POWER

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Look the Part

MANY a man well qualified to play a leading role in life is relegated to the chorus or kept behind the scenes simply because he does not look the part.

I do not refer to make-up; to that faculty of appearing by artificial devices and aggressive presumption to be something that one is not. Nobody has a more supreme contempt than I for the fellow with the marble front and the ivory head, the aggressive personage, who shoves better people aside just by meritless self-assertiveness and well-groomed personality.

But I do deplore the disadvantages by which men of real merit handicap themselves by lack of attention to personal appearance.

A true heart can beat just as well beneath a bosom shirt as under a flannel blouse; and the dress suit can get to places and to people that the flannel shirt cannot.

We recommended an engineer once to a public institution. He was a good engineer, better than the job required, although it was one of considerable class. After an interview the secretary of the Board informed me that in personal appearance and presentability the candidate did not accord with the high ideals of the directors.

A man need not be a fop, but he stands in his own way when he goes about untidy and careless and unkempt. Conscious worth and real ability usually carry with them a sufficient amount of self-respect to impel attention to appearances, and appearances are what the world judges by. The untidiness which usually goes with failure and lack of ability is apparent even to the passer-by, but real worth becomes apparent only to the intimate.

No man can estimate the dividends which he collects on the money that he pays to his barber and bootblack.

You can wear only one suit at a time, and you will not wear out any more shoes or clothes if you have enough to be presentable on all occasions.

I love a manly man, but one does not need to wear his working clothes to church or to use coarse and offensive language to assert his practicality and manliness.

Many a man has been chosen over others just because he looked like success, and many a poor fellow is stuck socially and industrially in a plane away below his merits because he persists in looking like mediocrity.

F. R. Low

Veteran Engines Give Way to Modern Turbines

By G. W. ATKINSON*

After twenty-five years of service at the Springfield Armory, old-style engines and belt-driven generators are replaced by modern turbo-generator units. The engines, one of which had been in service since 1856, showed evidence of good care and, except for the main bearings, were in good condition.

AT THE Hill shops of the Springfield Armory the main source of power depended upon a twin tandem-compound condensing Philadelphia Corliss engine, Fig. 2, which was installed in 1893. This engine was rated at 480 i.hp., running at 82 r.p.m., and using saturated steam at 125 lb. gage pressure. It was belt-connected to a jackshaft, which was belted to a main lineshaft, and this in turn drove over a mile of main lineshafting ranging from 2.4 to 4.9 in. in diameter. The main lineshaft, except for the wood-working building, operated at 150 r.p.m. It was provided with plain babbitted bearings and numerous pulleys from wood to solid cast iron, which were belted to hundreds of small countershafts and jackshafts driving the various machines. The man who originally laid out the drives must have been an artist in his line of work, as it was no uncommon feature to see double-thick leather belts up to 22 in. in width making quarter-turn bends.

In the Annex building there was also a steam engine set in a room that at one time had been a museum. Great respect had been given this prime mover for the service it had rendered during previous wars. It was a 200-hp. Woodruff & Beach vertical walking-beam type of engine, Fig. 1, operating condensing, at 38½ r.p.m. and belt-connected to the main lineshaft through a jackshaft, clutches, etc. It was first installed at the Water shops in 1856. At that time it held the honor of being the largest steam engine in the City of Springfield. After the Civil War it was removed to the Hill shops. The engine was of the single-cylinder type, 36 in. diameter with a 48-in. stroke and a common 20-ft. diameter flywheel having a 36-in. face. It operated normally on an initial steam pressure of 32 lb. gage.

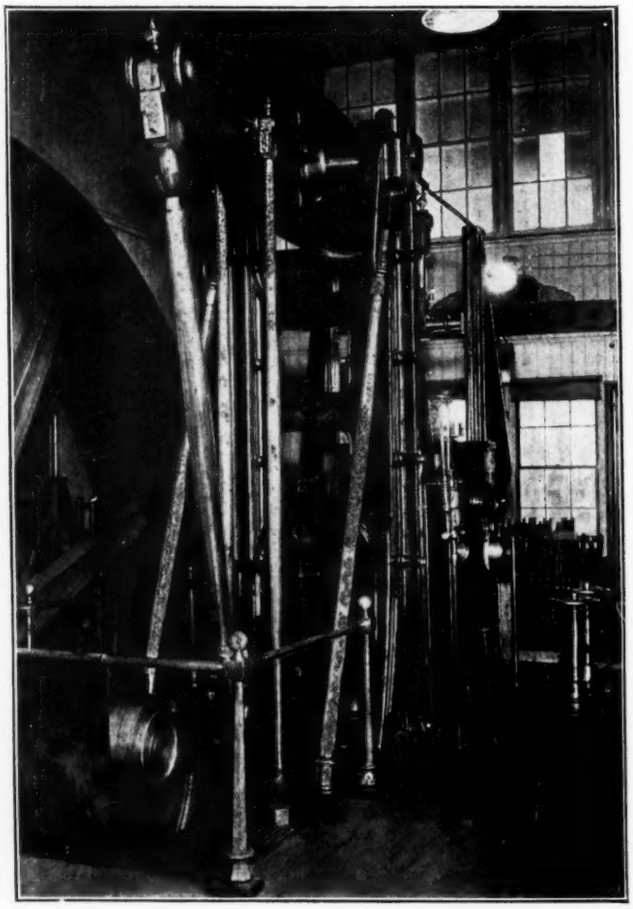

FIG. 1. A 200-HP. VERTICAL WALKING-BEAM ENGINE INSTALLED IN 1856

During the spring of 1918 there was a scarcity of mechanical power, and as the shops were not yet electrified, it became necessary to operate the engine for about three months on a load of approximately 150 hp. The steam supply for it came from two 1,500-sq.ft. water-tube boilers, which also furnished heating and manufacturing steam. An observer in the boiler room could count the strokes of the engine by watching the variations of the steam-gage needle which corresponded with the piston travel. There was not time to conduct an efficiency test on the engine, but it is evident that the water rate was high when using steam at so low an initial pressure and obtaining 24 to 26 in. of vacuum in the condenser. In order to save fuel, the engine was shut down as soon as other conditions would permit.

At the Water shops plant, the prime power was furnished from a 350-i.hp. twin, single-cylinder, condensing Slater steam engine; one 400-hp. double, horizontal Holyoke waterwheel and one 200-hp. single, horizontal waterwheel, all being connected by means of rope and leather belts and clutches to the main lineshafts. There was also a motor-generator set of 300-hp. capacity, arranged to transform the alternating current from city source to direct current for driving some direct-current motors. The lighting and signal systems at each plant were as obsolete and inadequate as the power systems.

As soon as the demand for increased production was made the potent factor in the summer of 1917, there was the corresponding necessity for more power and proper

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drives. Indicator diagrams were regularly taken on the steam engines to determine working conditions and the amount of extra load that they would safely carry while working 21 hours each day. To obtain more work out of the engine, the steam pressure at the Hill shops was raised from 125 to 140 lb. gage and, at times, 100 deg. F. superheat was carried. The highest load obtained was 613 i.hp. on the normally rated 480-i.hp. engine.

It is quite remarkable that only a few slight accidents occurred and practically no shutdowns were necessary on account of the prime movers needing repairs. The wonderful service of the engines was largely due to the excellent care that had been given them in former years. The engines were dismantled after giving 20 to 25 years' service, and their greatest defects showed mainly in the large bearings, which were in need of relining.

One safety feature in connection with the Hill-shops plant should be mentioned—the steam-throttle valve was provided with an electro-magnetic trip operated from push-buttons scattered throughout all the shops. Should a countershaft belt become loose or entangled and endanger the life of a near-by workman, an operator would run to the nearest "emergency stop," push the button and thus cause the whole plant to be shut down. The 1,500 or more employees would probably be idle a few minutes, waiting for the signal to start work, wondering the while what the "enemy agent" had done that time. That method of control was devised many years ago and was applicable to the steam engine with main-line drives, but it did not meet requirements of modern practice, as it offered no means of the desired flexible control.

In order to install a new steam-turbine plant and electrify the shops, it was necessary to conduct load tests and estimate the future power demands according to the probable production schedules. An interesting point in connection with the load tests showed that 52 per cent of the total power required to run the whole Hill shops was consumed in friction losses for running the engine and all the main lineshafting and countershafting idle without any of the machines being in operation.

It was decided that the new electric plant at the Hill shops should consist of two 625-kva. steam turbo-generator sets, operating condensing, with initial steam at 150 lb. gage, 100 deg. F. superheat, and generators producing three-phase 550-volt 60-cycle current. Duplicate generating units were installed to provide continuity of service in case of either set being out of order for repair and adjustment. The two turbine units are shown in Fig. 3.

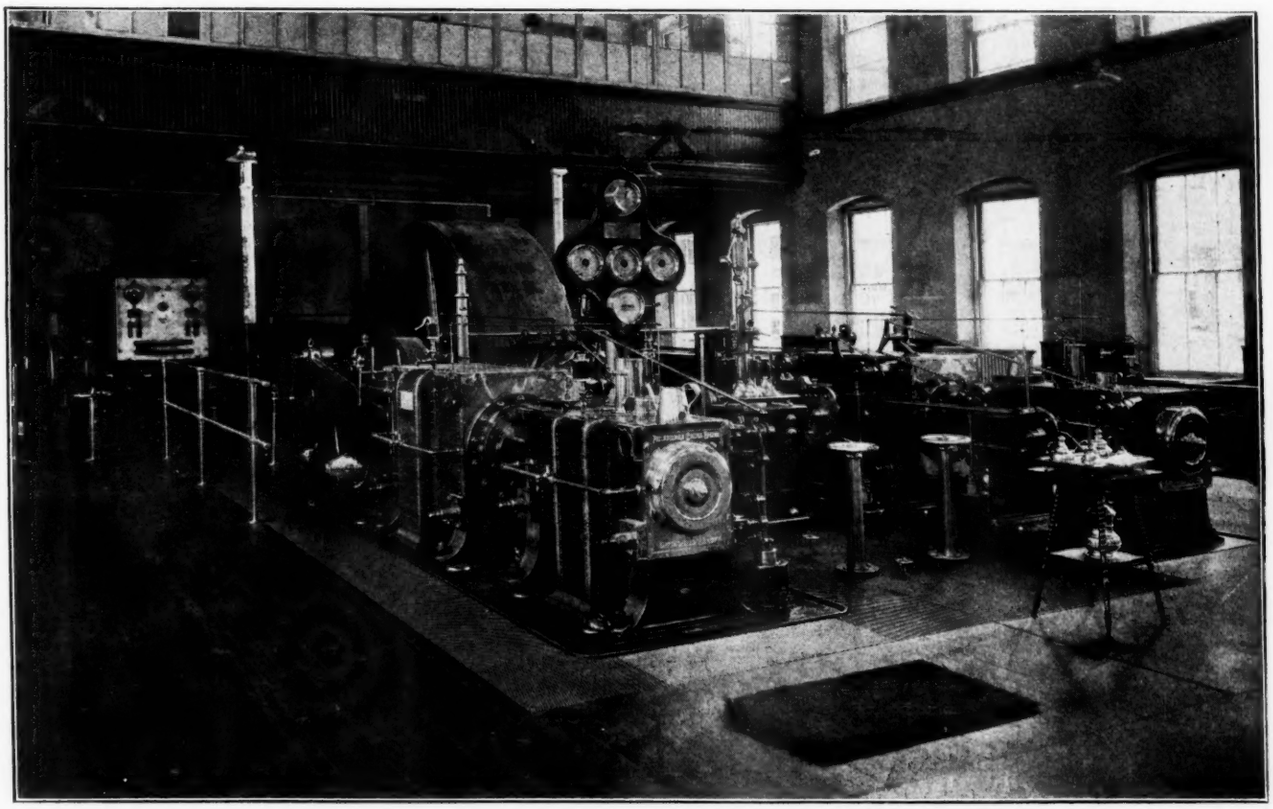


FIG. 2. OLD TWIN TANDEM-COMPOUND CONDENSING ENGINE

When the maximum load is sufficient, the two units can be operated in parallel to supply the needs, but under a peace-time condition one unit is of ample capacity to supply the demand. There was also provided a "throw-over" service, so that the electric load or a portion of it can be obtained from the city source. To accomplish this feature, it was necessary to install Scott-connected transformers to receive the city service at 5,500 volts two-phase and reduce it to 550 volts three-phase current.

The steam turbines are of the extraction type, which

permits steam from the first stage to be used for heating purposes. The quantity of steam that can be taken for heating depends on the load carried. Generally, each 40 lb. of steam extracted will produce one kilowatt-hour and still have approximately 90 per cent of the heating value in it.

Each turbine is provided with a surface type of condenser. One auxiliary has an engine-driven piston-type air-removal pump and water-circulating pump driven by a direct-connected steam turbine with the exhaust used for heating purposes in winter months. The other auxiliary is equipped with an air occluder for ejecting the entrained air, and a separate motor-driven water circulating and condensate pumps. The latter equipment is desirable and economical for summer use when exhaust steam is not used in large quantities. The condenser cooling water is supplied from a spray pond, Fig. 4 that was constructed in an open area at the rear of the boiler plant. It has proved successful and effects a substantial saving in water bills over that paid out for city water, which was formerly used in the condenser under the main steam engine. All condensate water is returned to the boiler-feed tank, and all makeup water is automatically fed from the warm-water line leading to the spray pond. It has been found by tests that the turbo-generator units when carrying a load from two-thirds to full load will produce a kilowatt-hour for approximately 21 lb. of steam including all losses in auxiliaries.

The vacuum that is obtained is remarkably good for a small plant. Throughout all the winter months it will range from $\frac{3}{4}$ to 1-in. absolute and at times will operate on $\frac{1}{16}$ in. This is produced without an unusual expenditure of energy for circulating the cooling water, as generally it is only necessary to maintain 10 lb. pressure on the whole circulating system.

After careful consideration, the three-phase 550-volt service, instead of the 220- or 440-volt current was installed at the Hill shops. The electrical distribution system was accomplished by running a main three-phase power feeder from the power-plant switchboard to each of the large buildings and one to the large group of buildings that were located on the west side of the street.

The motorization of the production machinery presented the most difficult problems to be solved. There was no formula by which the proper size motor could be accurately determined to drive a certain miscellaneous group of machines when operating on a variable production schedule. On the other hand, conditions did not offer any suitable means of making practical operating tests to determine the actual loads. However, a 20-hp. direct-current motor was used to a good advantage in making load tests in certain typical sections of the plant.

After conducting a few load tests on the old lineshafting provided with plain bearings, which in some places was quite badly worn, it was ascertained that the required starting torques were generally too severe for squirrel-cage motors. In order to get proper ratios between the main lineshaft pulleys and motor-driving pulleys, it was also necessary to raise the speed of the main lineshaft generally from 150 to 225 r.p.m. The couplings were provided with $\frac{1}{4}$-in. iron spacers at various intervals in order to break the long lines and to shift portions of loads from one motor to another according to the operating conditions. Pressed-steel hangers with roller bearings were installed and rendered excellent service. On a 140-ft. length of main lineshafting with all connecting belts in place and equipped with roller-bearing hangers, a 20-hp. motor could easily start it revolving, whereas with the old installation it would

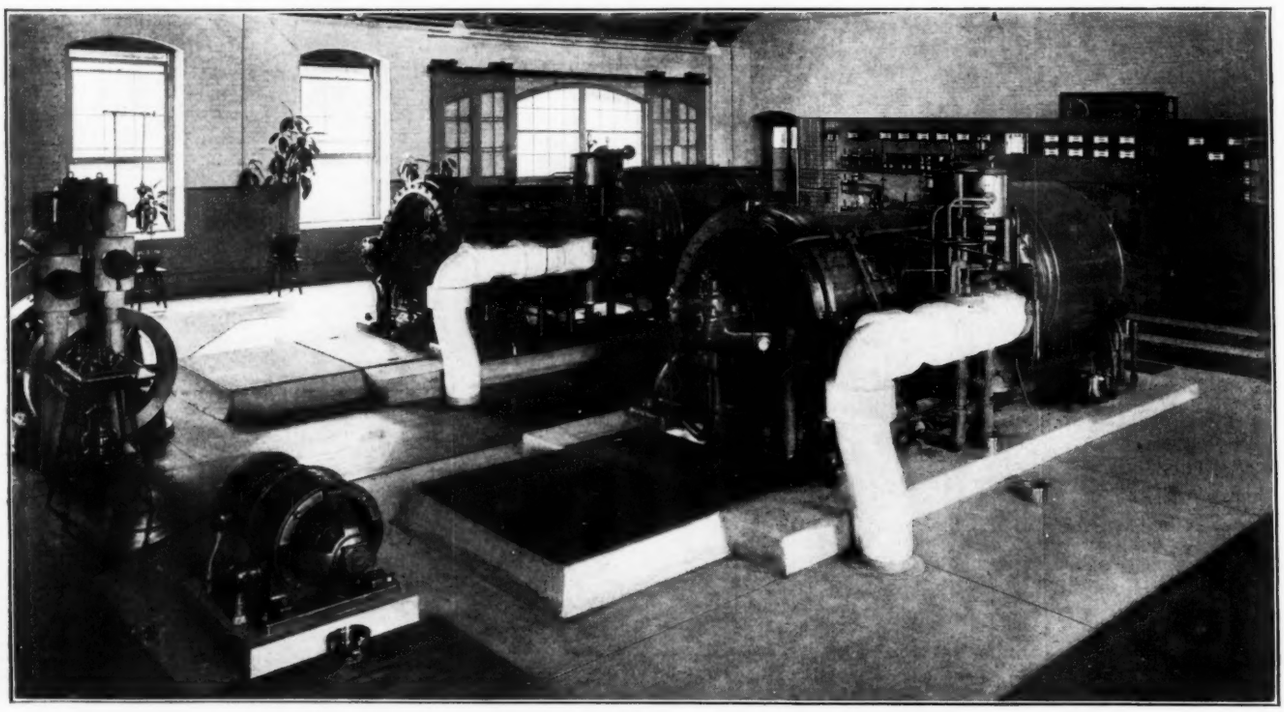


FIG. 3. TWO 625-KVA. TURBO-GENERATOR SETS AT THE HILL-SHOPS PLANT

require several times that equivalent torque to set the shaft moving.

As there were several thousand production machines in the shops and generally each one taking from ¼ to 2½ hp. to drive it, the situation was not favorable for a separate motor on each machine. Where a single machine required 5 hp. or more to drive it, an individual motor was installed for that particular service.

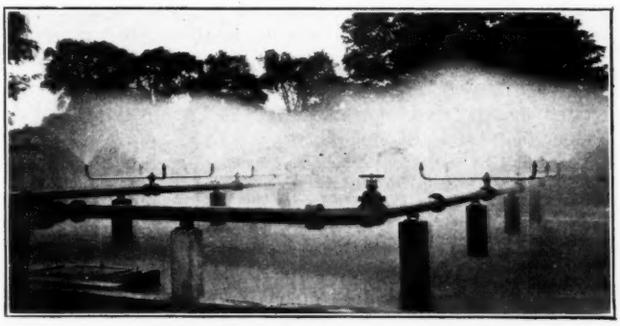


FIG. 4. VIEW OF THE SPRAY POND

This arrangement was found satisfactory, especially in the wood-working shops where the load conditions were of a highly fluctuating character.

Making a Worn Oil Engine Pull Its Load

BY CHARLES QUINCEY

Frequently, engineers, in order to keep a plant in operation, find it necessary to adopt methods that are open to criticism, but are absolutely necessary under the circumstances. The writer has had such an experience, and it should be of interest to others engaged in oil-engine operation.

The plant contained two Diesel engines of the vertical three-cylinder type. One was a 225-hp. three-cylinder unit, while the second machine was a six-cylinder double unit, consisting of two 225-hp. engines with the flywheel and generator between the two frames.

These engines had been in operation for about fourteen years, and in all this time the cylinders had never been rebored. The wear on the cylinder and piston walls at last reached a point where it was almost impossible to start the double unit. The 225-hp. engine had not been run so much and had better compression, so started fairly easy. The double unit, being run most of the time, of course had the greatest wear, with a resulting low compression pressure, seldom over 325 lb. per square inch.

To make matters worse, the wear on the two cylinders that were fitted with the air-starting mechanism was such that the starting air blew down along the piston, leaking very badly. The large inertia of the long crankshaft, heavy flywheel and generator rotor required a greater starting effort than could be supplied by the leaky air-starting cylinders.

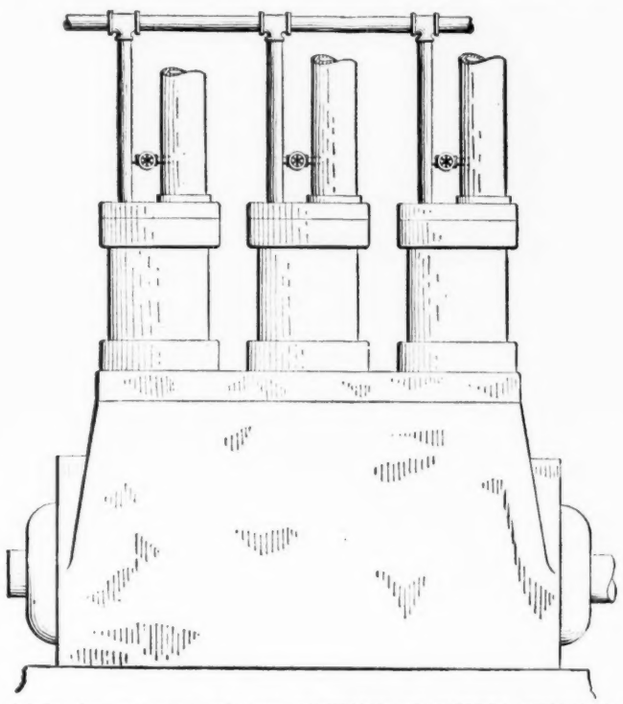
At first it was usual to block open the valves on the other cylinders, relieving the engine of the compression in these cylinders. This, however, was of little advantage after the cylinder wear became so bad that, even though the speed came up to normal, the compression was too low to ignite the fuel charge in any of the cylinders.

It was impossible to shut down long enough to rebore the cylinders until a new engine was purchased to carry the load. As a last resort we decided to experiment with the introduction of a small amount of water into the engine cylinders with the thought that the water would seal the space between the cylinder walls and piston, this clearance being approximately $\frac{3}{16}$ inch.

A half-inch line was taken off the cooling-water discharge line from each cylinder and was led into the air suction nipple as shown in the illustration. The branch globe valves were "cracked" a small amount, and by experiment the least amount of water that would seal the pistons was fed in with the suction air. We found that this water covered the cylinder head and part flowed down along the piston, thoroughly sealing the clearance. The compression came back to normal and the engine ran very nicely.

Owing to incomplete combustion with low compression, the engines had carbonized badly and the fuel consumption was high. With the water feed the carbon disappeared and the fuel consumption was lowered a marked amount.

It was impossible to determine the actual amount of water fed, but a fairly close check was gained by comparing the crankcase supply of water. This engine used splash lubrication in the crankcase, which normally required 15 gal. of water every two hours. With the cylinder water feed no water was poured into the crankcase and the amount dripping down into the frame was enough to keep the splash level constant—so we fed at least 7½ gal. per hour plus the amount evaporated into



FEEDING WATER TO AIR SUCTION OF DIESEL ENGINE

steam in the cylinder. In fact, we often had to remove a few gallons of the crankcase mixture.

This method may appear radical to most engineers, and so it is; but in a plant where the engine must run, radical methods must at times be followed. We shut down this unit when the new one was installed and rebored each cylinder. The water probably caused increased wear due to washing off the lubrication, but as a means of making the engine pull its load the scheme was a success.

Keeping Down the Furnace Losses

A Study of the Preventable Losses, Together with Charts for Determining Flue Losses Without Knowing the Fuel Analysis

By PROFESSOR R. T. HASLAM*

HEAT losses in boiler furnaces may be divided into two classes, those due to the operation of the boiler furnace itself and those due to other causes, chargeable for the most part to management and engineering. This classification of losses separates the responsibilities of the fireman from the responsibilities of the company or organization, so that each may see his own problem unclouded by conditions outside of his control.

Once the equipment is installed, the coal purchased and the coal storage decided upon, the following losses are beyond the control of the fireman: (1) Loss due to moisture in fuel; (2) loss due to moisture formed in burning the hydrogen in the fuel; (3) loss due to moisture in the air; (4) loss due to radiation. While these losses are under the control of the furnace designer, (together with the engineer through his choice of coal), they can be economically reduced to a certain minimum only. The design of furnace and the choice of coal also greatly influence the stack temperature and the following stack losses: (5) Heat carried by stack gas; (6) undeveloped heat due to unburned CO. However, the amount of excess air used, *controllable by the fireman*, changes the magnitude of both these latter losses; an increase in the excess air increases the heat carried up the stack by the flue gas and decreases the undeveloped heat due to unburned CO.

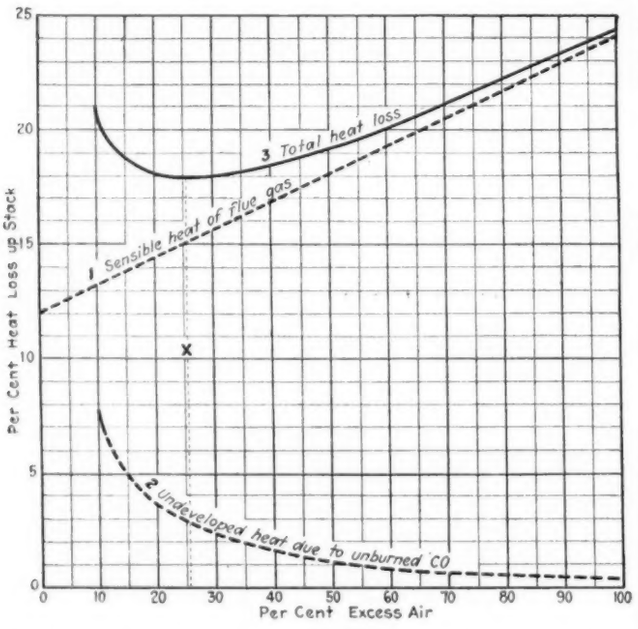


FIG. 1. AT THE POINT (×) OF BEST EFFICIENCY SOME CO IS PRESENT

For a given design of furnace and a given kind of coal or oil there is a certain amount of excess air that gives the most economical operation. That is to say, there is a point where the sum of the heat carried by the stack gas and the undeveloped heat due to unburned CO is a minimum, and at no other point is the sum of these two losses so low. The only other loss that is due to both design and operation is that arising from unburned coal in the refuse ash.

Discussion of Operating Losses

The size of these losses for good average operating conditions is shown in the accompanying table (data taken from "Mechanical Engineer's Handbook"; Marks, p. 898). It is evident that three-fourths of all the loss falls in the second class, where management, engineer and fireman are jointly responsible. Half of the total heat is carried up the stack by the flue gas. After the equipment is installed, the management can do little directly to lower these losses and the engineer can only specify that coal which will give the lowest combined stack loss and unburned coal in the ash, when the furnace is operated under the best possible conditions. The fireman, however, can increase or decrease these losses greatly by his daily operation. It may be said that the losses in the first class (due to management and engineering) are unpreventable; first, because after the furnace is in operation little can be done to lower them, and secondly, in a well-designed modern furnace these losses are already almost as low as is economically possible.

LOSSES IN BOILER OPERATION

		Percentage of Total Heat of Fuel	Percentage of Total Loss
	A—Losses not primarily due to operation.		
(1)	Loss due to moisture in the coal	0.35	1.1
(2)	Loss due to moisture formed in burning the coal	3.26	10.4
(3)	Loss due to moisture in air—negligible	...	...
(4)	Loss due to radiation and unaccounted	4.91	15.6
	Total	8.52	27.1
	B—Losses greatly affected by operation		
(5)	Loss due to heat carried by flue gas	16.37	52.0
(6)	Loss due to undeveloped heat of unburned CO	1.78	5.8
(7)	Loss due to unconsumed carbon in ash	4.75	15.1
	Total	22.90	72.9

But the losses in the second class may fluctuate widely from day to day, particularly those due to heat carried by the flue gas and the undeveloped heat of unburned CO. Oftentimes, half of this loss is distinctly preventable. The purpose of this article is, first, to show the importance of these losses and how they may be reduced and, second, to give charts that will facilitate their calculation.

First, taking up losses (5) and (6), the ideal is to operate so that the sum of these two losses is a minimum. Decreasing the excess air usually increases the undeveloped heat of unburned CO. On the other hand, the volume of stack gas decreases, so that the heat carried by the flue gases is reduced. Increasing the excess air produces the opposite conditions. Therefore, we have to balance a loss against a gain and operate at that excess air which is most economical. This situation, for a typical boiler and coal, is shown graphically in Fig. 1.

In Fig. 1 the stack loss due to the volume of hot flue

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gas is shown as dotted curve 1, while the loss of heat due to unburned CO is shown as dotted curve 2. The sum of these two losses is the important thing and is shown as solid curve 3. It is seen that, as the amount of air is increased over that theoretically required, the total heat loss (curve 3) drops on account of the great drop in the loss due to unburned CO. However, as the amount of air is further increased, the rate at which we gain heat through a decrease in the unburned CO gradually slows up until, at about 25 per cent of amount of excess air would, of course, again lower the stack temperature, owing to great dilution of hot furnace gases with cold air.

All of this is well known, but few operators realize: First, that there is this balance which must be obtained for economical operation; second, that with a furnace having a high stack temperature the most economical percentage of excess air is lower than with a furnace having a low stack temperature; and third, that for most boiler furnaces this best point for excess air is

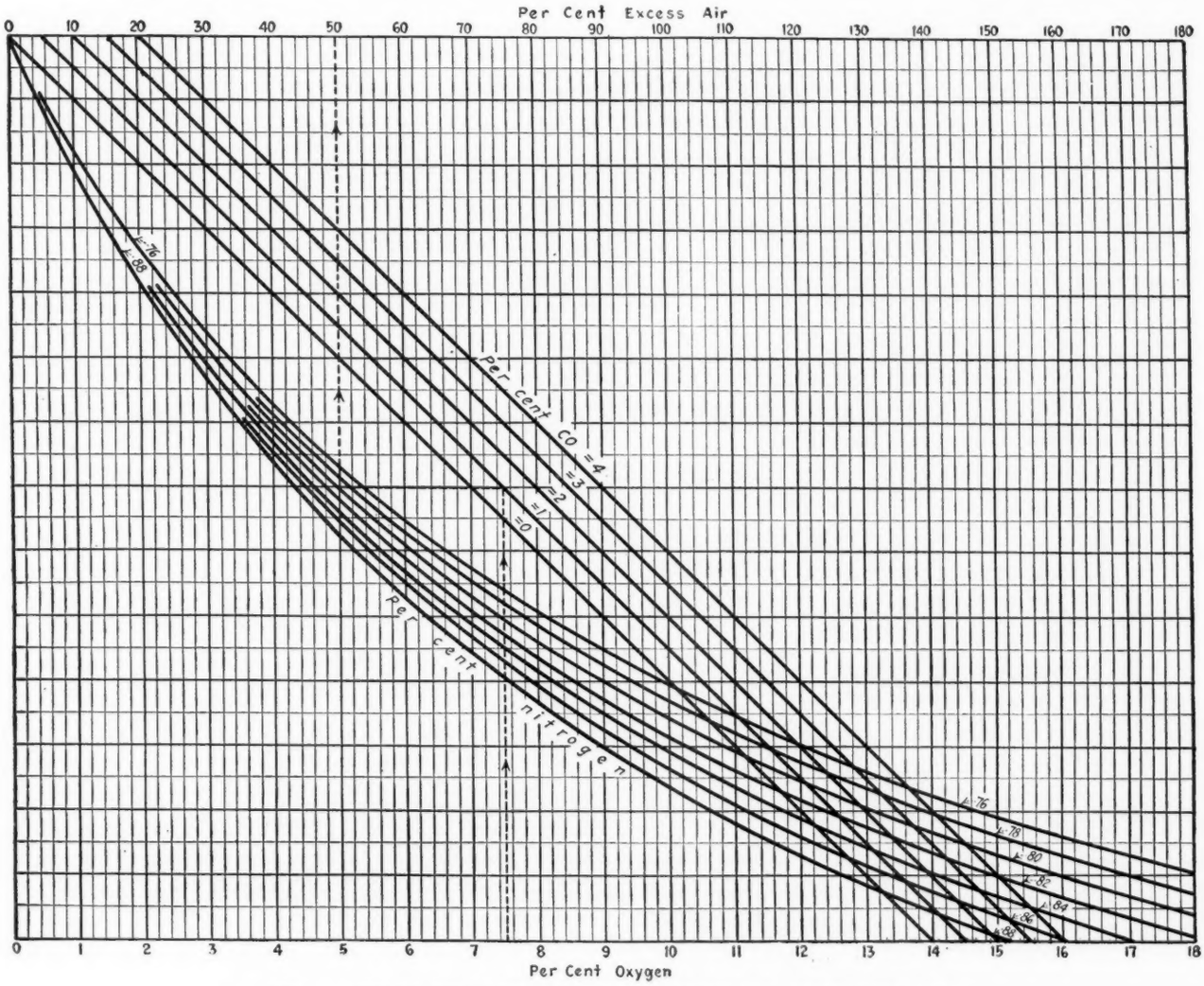


FIG. 2. CHART FOR DETERMINING PERCENTAGE OF EXCESS AIR
Run vertically from "Per Cent Oxygen" to "Per Cent CO," horizontally to "Per Cent Nitrogen" and vertically to "Per Excess Air"

excess air, in the case shown, this gain is just counterbalanced by the increased loss due to the larger volume of stack gases. Any further increase in the supply of air increases the total loss since, from this point on, the loss due to the sensible heat of the flue gas more than offsets the gain in burning up the remaining CO. Fig. 1 is drawn on the assumption that increasing the percentage of excess air does not change the stack temperature. Actually, it does tend to increase the stack temperature,[1] and this effect emphasizes the harm of too great a percentage of excess air. The use of a large such that there should be a measurable amount of CO present in the stack gas. If there is no CO in the stack gases, it is certain that the furnace is not being operated most effectively.

To determine the percentage of excess air, the amount of heat lost up the stack by the hot flue gases and unburned CO, it is necessary only to measure the temperature of the stack by a high-temperature thermometer or pyrometer and to analyze the stack gases with an Orsat apparatus. Once the equipment is installed, only a little practice is needed to obtain quite accurate data. It is well to mention here that the graduate and leveling bottle of the Orsat should be filled with mercury instead

[1] "Principles of Combustion in the Steam-Boiler Furnace," by A. D. Pratt, published by Babcock & Wilcox.

of the usual water if accuracy is desired, only three or four drops of water being kept on top of the mercury in the graduate, as water in the graduate dissolves too much CO_2. If the flue gas is analyzed carefully, the coal does not have to be tested for its B.t.u. content nor must its composition be determined by chemical analysis. The accompanying charts obviate these determinations.

Figs. 2, 3 and 4 have been prepared for the purpose of enabling the man in the plant to determine quickly: First, the percentage of excess air; second, the percentage of heat in the coal lost by the sensible heat of the stack gas; and third, the percentage of heat in the coal lost by unburned CO. These charts apply to any solid fuel such as coke, anthracite, soft coal or lignite and to fuel oil as well.[2] The only practical case where

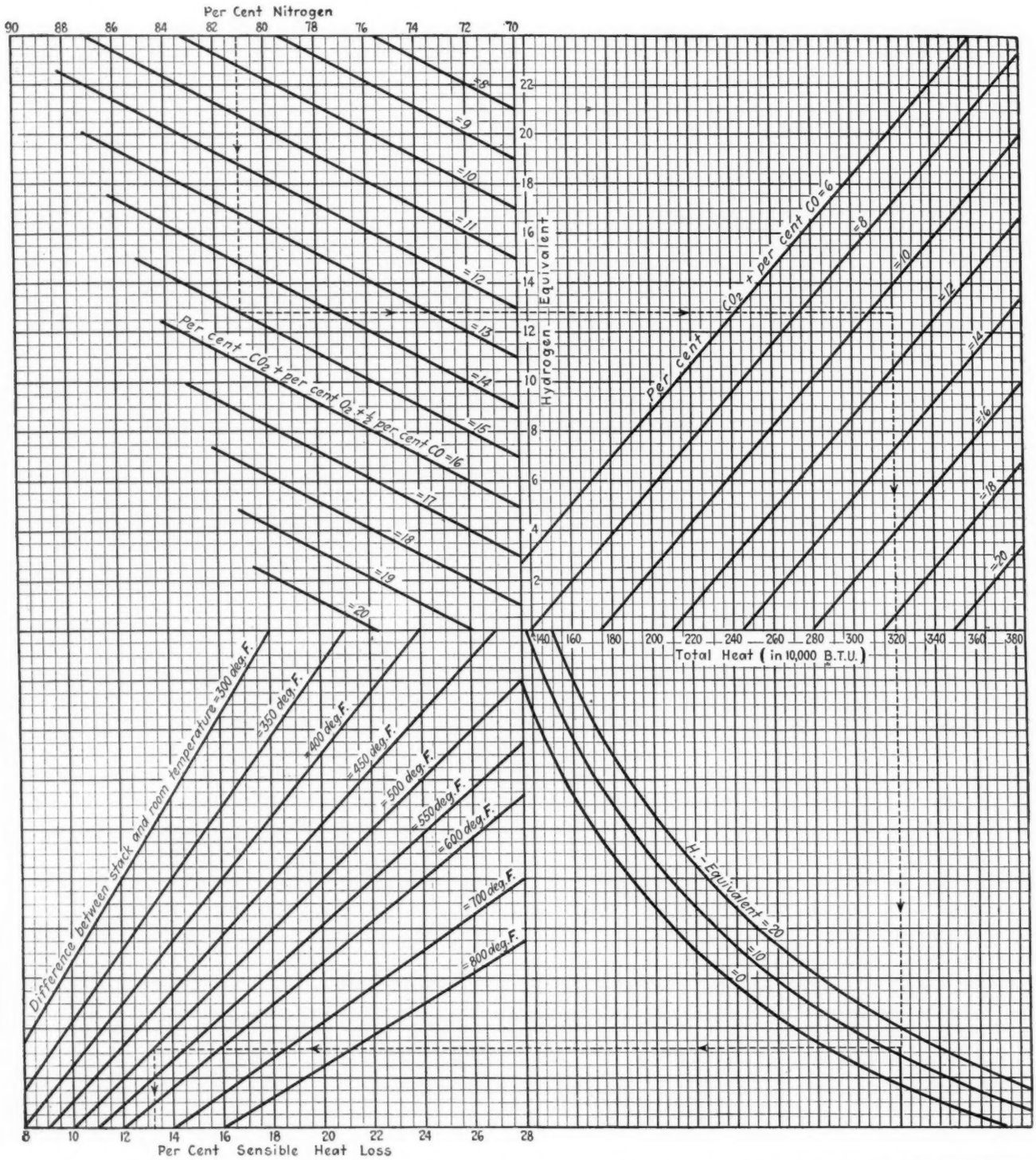


FIG. 3. CHART FOR DETERMINING PERCENTAGE OF HEAT IN COAL LOST AS SENSIBLE HEAT OF STACK GASES

Start with "Per Cent Nitrogen" at the top of upper-left quadrant. Then follow through the four quadrants in the manner illustrated by the dotted line. At the bottom of the lower-left quadrant will be found the loss due to the sensible heat of the stack gases expressed as a percentage of the heat in the coal. See text for further explanation.

[2] In preparing these charts, the total heat in the fuel has been determined on the basis of Dulong and Petit's law. This is close for coal, and even in extreme cases of fuel oil is usually not over 8 per cent out.

they do not apply is in the use of producer gas or blast-furnace gas.

Before these charts can be used, it is necessary to get the temperature and analysis of the stack gases. The CO_2, O_2 (oxygen) and CO are determined by absorption in an Orsat. The N_2 (nitrogen) is obtained by adding the percentage of CO_2, O_2 and CO and subtracting the sum from 100 per cent.

The method of reading the charts is given in their captions. The following paragraphs illustrate the manner of using them, working out the particular solutions shown by the dotted lines:

Turning to Fig. 2, suppose the stack gas contains 7.5 per cent of O_2, 1 per cent of CO and 80 per cent of

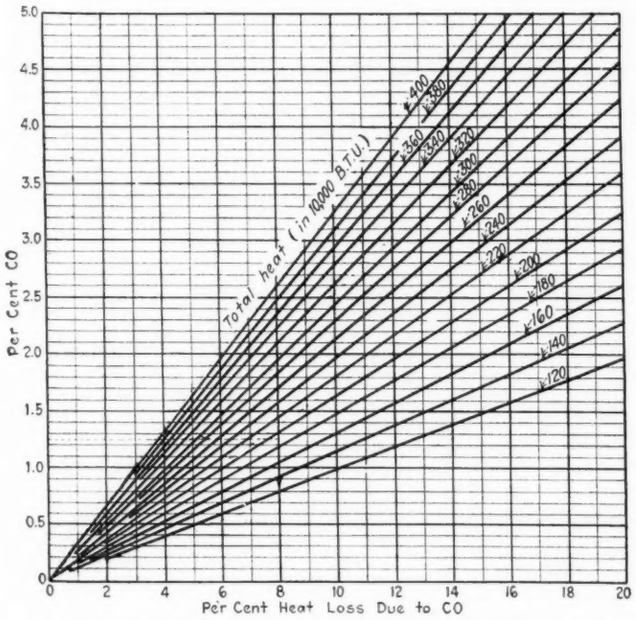


FIG. 4. CHART FOR DETERMINING PERCENTAGE OF HEAT IN COAL LOST IN CO

Start at left with "Per Cent CO." Move horizontally to the line marked with the value of "Total heat (in 10,000 B.t.u.)" found when passing from the upper-right to the lower-right quadrant in Fig. 3. Move vertically to the bottom scale which gives the CO loss expressed as a percentage of the heat in the coal.

N_2. Enter the bottom scale (O_2) at 7.5. Rise vertically to the line marked "Per cent CO = 1." Move horizontally to the curve marked "80 Per cent Nitrogen." Rise vertically to the top scale, where the excess air is read as 50 per cent. It is not necessary to use this chart in getting the heat losses. These can be obtained by Figs. 3 and 4 alone.

By means of Fig. 3 it is possible to determine the percentage of the heat in the coal that is lost in the sensible heat of the stack gases. As previously stated, it is not necessary to know the analysis of the fuel or its heating value. All that is needed is the temperature and analysis of the stack gases.

To illustrate the use of this chart, suppose the stack gases are 500 deg. above room temperature and that they have the following analysis: CO_2 — 2.8, O_2 — 8.2, CO — 8.0 and N_2 — 81.0 per cent. Start at 81 per cent of nitrogen on the upper left-hand scale. Drop to the line marked "Per cent CO_2 + per cent O_2 + $\frac{1}{2}$ per cent CO = 15" ($2.8 + 8.2 + \frac{8.0}{2} = 15$). Move to the right to the imaginary line for "Per cent CO_2 + per cent CO = 10.8" ($2.8 + 8.0 = 10.8$). This line comes, of course, between the lines marked 10 and 12. In moving horizontally as just described, note at what point you cut the vertical scale marked "Hydrogen Equivalent."[*] In this case it is 12.8. Hold this figure for later use.

Now drop vertically to the curve for "*H* equivalent = 12.8," the figure that was previously noted. (In dropping note the "Total heat in 10,000 B.t.u.,"[*] in this case 320. This number will be needed in using Fig. 4.)

Move horizontally to the left to the line marked "difference between stack and room temperature = 500 deg. F." Then drop vertically to the bottom scale marked "Per Cent Sensible Heat Loss." The answer obtained is 13.2 per cent.

How Chart Fig. 4 Is Used

To illustrate the use of Fig. 4, suppose that the stack gas contains 1.25 per cent of CO and that in using Fig. 3 the "Total Heat (in 10,000 B.t.u.)" was read as 195. From 1.25 on the left scale move horizontally to the inclined line 195 (between 180 and 200). Then drop vertically to "Per Cent Heat Loss Due to CO." The answer is 8 per cent.

The per cent total stack loss is found by adding the per cent sensible heat loss, as found from Fig. 3, to the percentage of undeveloped heat as found from Fig. 4. By experimentally changing the excess air, the relative sizes of these losses may be varied, one going up when the other goes down (unless there is leakage of air around the setting, which should, of course, be stopped). The proper excess air is that which gives the minimum total loss. Keeping the loss at this minimum point is one of the fireman's main duties. To aid in this, a chart like Fig. 1 may be constructed for any particular furnace and coal.

The practical use of these charts may now be summed up in a few words. First make a few tests, operating the boiler with various percentages of excess air. In each of these tests get the temperature and analysis of the stack gas. Use the data obtained to get the sensible heat loss and the CO loss from Figs. 3 and 4. From the results obtained, plot a chart like Fig. 1. From this chart determine the proper amount of excess air for the given boiler and fuel.

New 1,000-Hp. Airplane Engine Weighs Only 2,200 Pounds

A new airplane engine which, though weighing only 2,200 lb., develops 1,000 hp., has been constructed by D. Napier & Son, Ltd., of England.

This new engine is to be fitted to a specially designed airplane now being built for the British Air Ministry for the coming trials. At the present time there are rumors that Prof. Hugo Junkers, of Germany, is building a huge monoplane which will carry four 1,000-hp. Junkers opposed-piston-type Diesel oil engines.

The capacities of passenger elevators vary from about 1,000 lb. in residences to 5,000 lb. in department stores, and from 2,000 to 3,000 lb. in office buildings. The capacity determines size of the car, which should be of sufficient floor area to provide not over 75 lb. per sq.ft., which is an accepted standard throughout the United States.

[*]The meanings of the terms "Hydrogen Equivalent" and "Total Heat in 10,000 B.t.u." may not be clear to the reader who is not expert in chemistry, but this is immaterial as they are used in a purely mechanical way in reading the diagrams. The explanations, involving some knowledge of gas chemistry, will not be given here. It should be noted, however, that "Total Heat in 10,000 B.T.U.." does not refer to one pound of coal, but to a certain volume of flue gas.

Lubrication—The Saybolt Viscosimeter

By W. F. OSBORNE*

SINCE absolute viscosities are difficult to measure directly, it has been necessary to provide some means of measuring a characteristic of an oil, which depends in turn upon absolute viscosity. The Saybolt viscosimeter has been designed with this end in view, and, on account of its comparative ease of operation and simplicity of construction, has been accepted by the United States Bureau of Standards and the American Society for Testing Materials as the standard instrument for the measurement of the viscosities of oils.

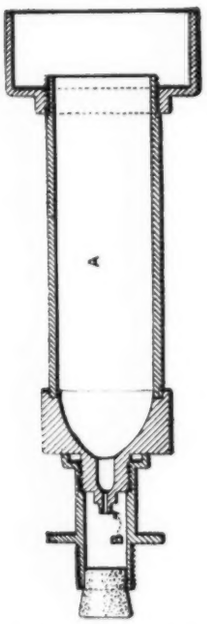


FIG. 1. SAYBOLT VISCOSIMETER CUP

The Saybolt instrument consists essentially of a cup *A* with a tubular outlet *B* at the bottom, as shown in Fig. 1. The viscosity test is made by filling the cup with the oil to be tested, withdrawing the cork stopper underneath the outlet, and measuring the time in seconds required for 60 cubic centimeters of the oil to flow out. Complete details to be observed in the accurate measurement of viscosities can be secured from the report of Committee D-2 of the A.S.T.M.

The only force available for driving the oil through the tube is gravity, and the force holding the lubricant back in the cup is its internal resistance, or viscosity. Consequently, the time required for a given quantity to flow through the orifice will be dependent upon both the viscosity and the density of the oil. The Saybolt viscosimeter therefore measures a unit equivalent to the absolute viscosity divided by the density, which is called *kinematic viscosity*.

The Saybolt viscosity is the number of seconds required for 60 cubic centimeters of oil to flow from the viscosimeter. When we say an oil has a Saybolt viscosity of 250, we mean that it requires 250 seconds for this standard quantity to flow through the tube. A heavy-bodied or viscous oil will require a long time, and a thin or fluid oil will require a short time and therefore have a low viscosity reading.

The relation between Saybolt viscosity and kinematic viscosity is shown in the chart. For Saybolt readings above 200 seconds the kinematic viscosity is about one-fifth of the Saybolt seconds viscosity. 200 Saybolt is equivalent to about 40 centipoises.

For all readings below 200 the Saybolt measurement is high and cannot be used for direct comparison of kinematic or absolute viscosities. For instance, a Saybolt reading of 150 corresponds to 31 centipoises, while 75 Saybolt is equivalent to 13.3 centipoises, and at lower viscosities the variation is still greater.

Consequently, when making any calculations on frictional resistance, the Saybolt readings should always be converted to kinematic viscosity or absolute viscosity. The chart shown on the opposite page is very convenient for the conversion, but when not available the following formula, derived by the Bureau of Standards and explained in Technological Paper 112, can be used:

$$\textit{Kinematic Viscosity in poises} = 0.00220\ t - \frac{1.80}{t}$$

where t is the Saybolt time in seconds.

The absolute viscosity can be calculated by multiplying the kinematic viscosity by the specific gravity of the oil at the temperature at which the viscosity was measured. When specific gravities are equal a direct comparison can be made on the basis of the kinematic viscosities, but when the oils are of different gravities, the correction should always be made.

Since the Saybolt reading is affected by the density of the oil, it should be remembered that if two oils have the same Saybolt viscosity, the oil with the lower Baumé gravity will actually have the greater absolute viscosity. This amounts to about 7 per cent when a 20-deg. Bé. oil is compared with a 30-deg. Bé. oil of the same Saybolt viscosity. The standard Saybolt viscosimeter is shown in Fig. 2. There are also a number of other types of viscosimeters in use which measure kinematic viscosity. The chart shows the relation between the more common types and a means of converting the reading from one instrument to that of another. Full directions accompany the chart.

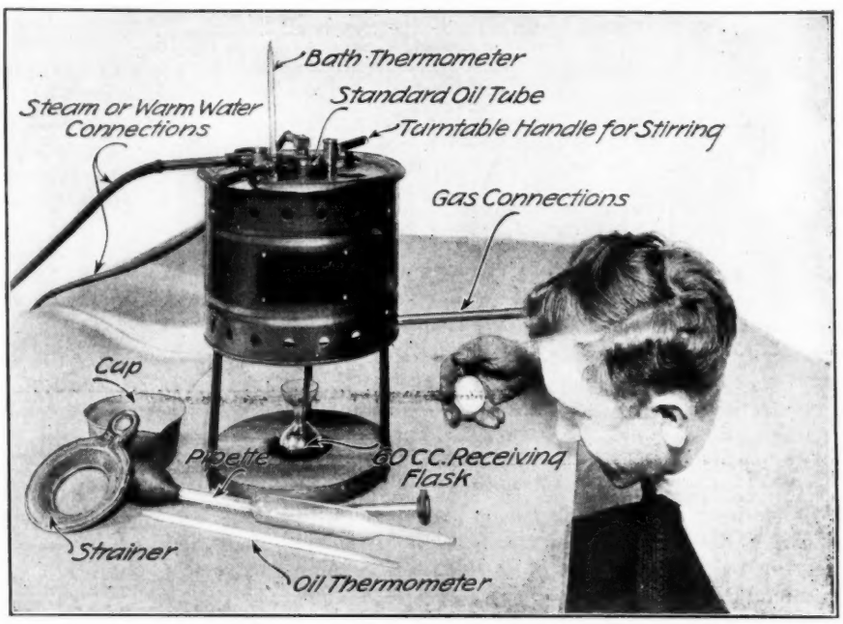
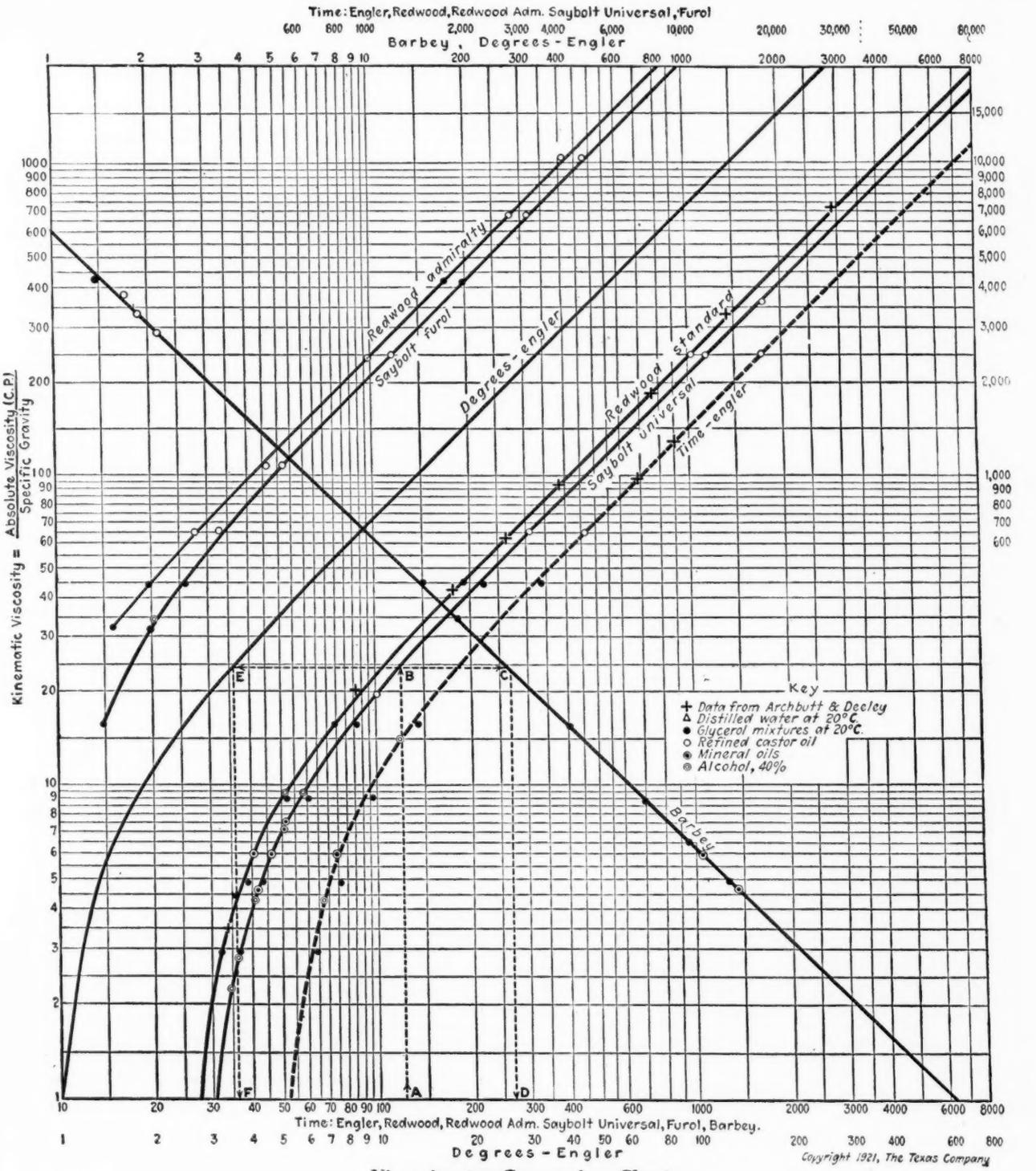


FIG. 2. METHOD OF USING VISCOSIMETER CHART

*Supervisor Manufacturer's Service, Texas Co.



Viscosimeter Conversion Chart

(Directions for Use of Chart)

OBJECT: To find the viscosity reading of a particular oil on any of the standard viscosimeters when its reading on one of the viscosimeters has been determined by experiment **at the same temperature.**

SCALES: There are two sets of scales which must not be confused with each other.

X: The scales at bottom and left hand side go together. They are the ones regularly used in practice applying to all ordinary oils.

Y: The scales at top and on right hand side go together. They are rarely used, applying only to very viscous products beyond range of other scales.

NOTE: There are two lines of scales at the bottom: (a) The lower scale applying only to degrees Engler. (b) The upper scale applying to all other readings, including Engler-time. In simply changing from one viscosimeter to another the scales at left and right are not used. The scales at top must never be used in connection with those at the bottom.

APPLICATION OF CHARTS: X: For ordinary cases.—**GIVEN:** Saybolt Universal Viscosity = 120". **DESIRED:** Case (a) Barbey reading. Case (b) Engler-degree reading. **PROCEDURE:** Find point on bottom scales for Saybolt Universal corresponding to 120" (A). Follow up vertically to curve marked Saybolt Universal (the known instrument) (B). (a) To get Barbey reading: Follow horizontally to curve marked Barbey (C). Drop down to bottom scale for Barbey and read (C). Reading = 265 deg. (b) To get Engler-Degree reading: Follow horizontally to curve marked Degrees-Engler (E). Drop down to lower of the two bottom scales, for Engler-Degrees and read (F). Reading = 3.62 deg., *i.e.*, 120" Saybolt = Barbey 265 deg. = Engler 3.62.

Y: For very viscous fluids beyond range of other scales. **GIVEN:** Engler-Degrees = 1,100 deg. **DESIRED:** Saybolt Furol reading. **PROCEDURE:** Find point on upper scales under Degrees-Engler corresponding to 1,100 deg. Follow vertically down to Degrees-Engler curve. Follow horizontally to curve marked Furol. Rise vertically to scales under Furol and read. Reading = 3,800", *i.e.*, 1,100 deg. Engler = 3,800" Furol.

Ideal Expansion in the Steam Engine

How to Construct the Adiabatic Curve—Departure of the Actual Expansion Line from the Ideal—Causes of Irregularities on the Indicator Diagram

IN THE last article we considered the expansion curve when the product of the pressure and volume remain constant. This is the theoretical mode of expansion of an ideally perfect gas when the temperature remains constant during the process. While steam does not remain at constant temperature during expansion, the re-evaporation of the water in the cylinder causes the relation of pv = constant to be substantially true.

In order to expand and do work most efficiently, the steam should lose none of its heat in the process except by converting it into mechanical energy. To investigate the perfect process, steam is imagined to operate in a cylinder the walls of which are impervious to heat —will not absorb or give out heat nor let heat pass through them. Such a cylinder is called an adiabatic cylinder, and the expansion of a gas or vapor that would take place within it, adiabatic expansion. This word comes from the Greek prefix *a*, signifying negation or not (a theist is one who believes in God, an *a*theist one who does not), *dia*, signifying through (diameter the through-measure) and *batos*, meaning to pass, the combination signifying *not-pass-throughable*. The first syllable is pronounced as in *addition* and the accent on the *bat*. If steam initially dry were expanded in a cylinder of this kind—that is, expanded adiabatically —its pressure would fall away faster than it would in the event that its temperature remained constant. This is for the reason that the work done by the steam in the cylinder is the result of the bombardment of the moving piston by the steam molecules. Since the piston is moving away from the steam, the velocity of the steam molecule is decreased after impact. The temperature and pressure are functions of the molecular velocity and so show corresponding decreases. In addition a pound

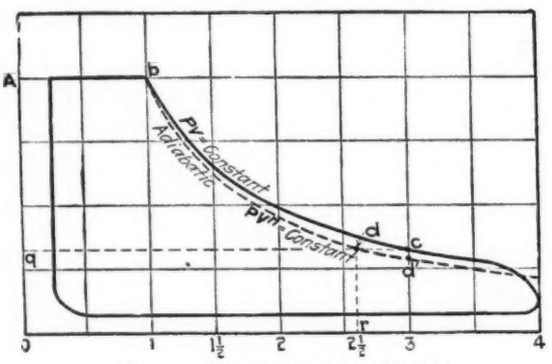


FIG. 1. ADIABATIC EXPANSION

of steam in a dry saturated condition contains a fixed amount of heat at a given pressure and temperature which amount is just sufficient to keep the steam dry. If by any means some of this heat is abstracted, a part of the steam is condensed, since unsufficient heat is present to maintain the entire amount of steam in its dry state. This condensation, in removing part of the steam of course lowers the pressure. Fig. 1 shows how such an expansion line, the relation of the pressures and volumes being expressed by the equation pv^n = constant, compares with the pv = constant curve.

Such a curve can be laid out with sufficient accuracy for ordinary purposes for steam initially dry saturated by means of Table I. Let $O1 = Ab$ in Fig. 1 represent the initial volume and $1b$ the pressure at cutoff. Erect other ordinates at distances equal to $O1$ from each other and number them consecutively as shown. If the ordinates are too thinly spaced, put in others

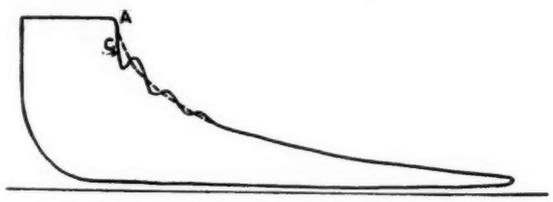


FIG. 2. EFFECT OF STICKING PISTON

between them and number them fractionally, as shown, so that the number of any ordinate will be the number of times the distance $O1$ that it is away from the clearance line or axis of zero volumes OA; that is, that the number of the ordinate will express the volume at that point in the stroke in terms of the initial volume.

TABLE I. ADIABATIC EXPANSION OF DRY STEAM

Pressures	Volumes										
	1	1¼	1½	1¾	2	2½	3	4	5	6	8
200	155	126	106	90	70	57	41	32	26	19	
180	140	113	93	82	63	51	37	29	23	17	
160	124	101	84	73	56	46	33	26	21	15	
140	108	88	73	64	49	39	29	22	18	13	
120	93	76	61	52	42	34	25	19	16	11	
100	78	63	53	46	35	26	21	16	14	9	
80	62	51	42	36	28	23	17	13	10	8	
60	47	38	32	27	21	17	12	10	7	6	
40	31	25	21	18	14	12	8	6	5	4	

The pressures upon the different ordinates may be found in the horizontal line of the table opposite the given initial pressure.

For other initial pressures or when there is moisture present initially, the curve may be drawn from the formula pv^n = constant, the value of the exponent n varying with the initial pressure and condition. Table II from Mark's "Mechanical Engineer's Handbook" gives the values for various pressures and percentages of initial moisture.

Since pv^n = constant $p_1v_1^n = p_2v_2^n$ and by substituting the value of the initial absolute pressure and the volumes at the initial and any other desired ordinate, we get $\frac{p_1}{p_2} = \frac{(v_2)^n}{(v_1)^n}$ and since v_1 is taken as unity $\frac{p_1}{p_2} = v_2^n$ or $p_2 = \frac{p_1}{v_2^n}$.

Rule: Multiply the logarithm of the number of the ordinate by the value of n for the given conditions of pressure and quality as given in Table II, and subtract the product from the logarithm of the initial pressure. The difference will be the logarithm of the pressure upon the ordinate the number of which was used.

There are various tables, charts and diagrams from which the volume of a pound of steam after adiabatic expansion to any pressure from any initial condition of pressure, superheat or contained moisture may be obtained, and the curve can be constructed by setting off the volumes thus found against the corresponding pres-

sures, but the foregoing will serve for present purposes. The other method will be shown in connection with analysis of the diagram later.

When steam is admitted to the cylinder, it comes in contact with surfaces that have been exposed to the lowering temperatures of expansion and to the low-temperature exhaust of the preceding revolution. Furthermore, these surfaces have been chilled by the evaporation, at the expense of heat drawn from them,

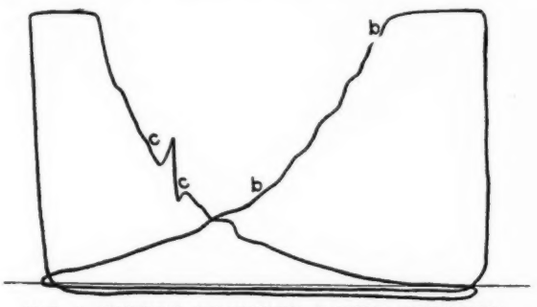


FIG. 3. EFFECT OF PENCIL LEVER FRICTION

of the moisture with which they were coated. The incoming steam, unless it is highly superheated, will be partly condensed by contact with these cooler surfaces, and when cutoff occurs there will be in the cylinder not a volume of dry steam, but a mixture of steam and water.

If the cylinder were of the ideal adiabatic sort, the adiabatic expansion line for steam with a given percentage of moisture could be laid out. But here comes in another complication. The containing surfaces of the actual engine continue to absorb heat from the high-pressure steam after cutoff has occurred and expansion commenced with further condensation as a result. Then, as the temperature of the steam is reduced by expansion, there comes a time when it is no hotter than the metal and the transfer of heat stops.

TABLE II. VALUES OF n

Initial Quality of Steam	Initial Pressures Lb. Absolute									
	20	40	68	80	100	120	140	160	180	200
1.00	1.131	1.132	1.133	1.134	1.136	1.137	1.138	1.139	1.141	1.142
0.95	1.127	1.128	1.129	1.130	1.131	1.131	1.132	1.133	1.134	1.135
0.90	1.123	1.123	1.124	1.124	1.125	1.125	1.126	1.126	1.127	1.127
0.85	1.119	1.119	1.119	1.119	1.120	1.120	1.120	1.120	1.120	1.120
0.80	1.115	1.115	1.114	1.114	1.114	1.114	1.113	1.113	1.113	1.113
0.75	1.111	1.110	1.110	1.109	1.109	1.108	1.107	1.106	1.106	1.105

Then, as the temperature of the steam gets lower than that of the metal, the heat transfer is reversed and the metal gives up heat to the mixture. Also, the hot water of condensation begins to boil as soon as the pressure gets below that corresponding to its temperature and is remade into steam at the lower pressures, so that, whereas, the volume at the pressure rd in Fig. 1 would have been only qd if the expansion were truly adiabatic, it might be qc due to the re-evaporation. On looking at it another way, while the expansion of the steam present as steam at the beginning of expansion would have carried the pressure down to d', at that point in the stroke there may have been enough steam evaporated by re-expansion to carry the pressure up to c.

It happens that for the ordinary unjacketed cylinder and with steam of ordinary quality the combined effect of all these actions and reactions is to produce an expansion line on the actual diagram following more or less closely the $pv =$ constant curve, but this test curve must be applied with an intelligent appreciation of the causes that have combined to make the actual curve and not with the idea that it is the natural curve for steam to follow and that any departure from it necessarily indicates some mechanical fault. The engine that produced the lower adiabatic curve would be the more efficient machine in the absence of mechanical causes such as leaks.

Departure from the Adiabatic

Some of the things that may cause the expansion line to depart from the adiabatic are:

Ratio of Expansion: Owing to the greater temperature range during expansion and to the fact that the condensation against the surfaces is a greater proportion of the smaller weight of steam used per stroke, the effects due to heat exchange are proportionally greater with a high rate of expansion.

Speed: The slower the piston moves the more time there is for condensation and re-evaporation. On very slow-running pumping engines the raising of the expansion line in the latter part of the stroke may be very noticeable.. Higher speed engines, on the other hand, often show an expansion curve below the $pv =$ constant.

Cylinder Size and Proportions as affecting the amount of containing surface per unit volume of contents.

Quality of Steam as affecting the amount of moisture present at the commencement of expansion. This includes, of course, the degree of superheat.

Jackets: The object of the steam jacket is to keep the cylinder wall so hot as to diminish or prevent condensation. The extent to which it does this will have a material effect upon the departure of the actual curve from the adiabatic.

Distribution of Steam: There will be less cooling effect in an engine having separate steam and exhaust ports than in a single-valve engine in which the steam must enter over surfaces that have just been washed by

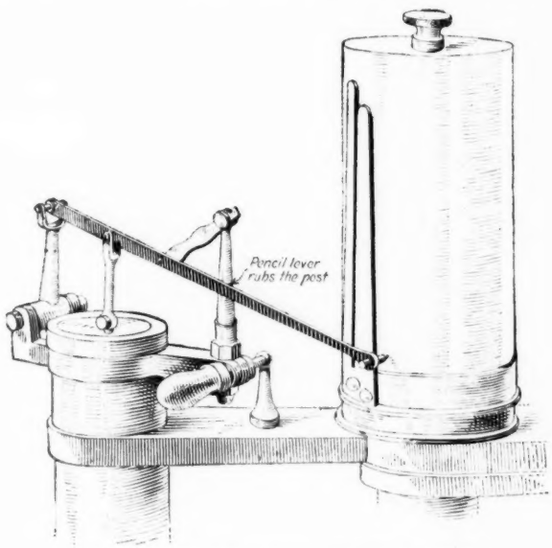


FIG. 4. LEVER RUBS AGAINST POST

the cool, moist exhaust, and still less in engines of the unaflow type in which the steam-jacketed head is never in contact with the outgoing steam.

Leaky Piston, Stuffing Box or Valves as varying the amount of steam involved while the ideal curve is laid out for a constant quantity.

Radiation and Convection, which on exposed cylinders, like those of the locomotive for example, may induce considerable condensation.

Condition of Interior Surfaces: It has been found

that there is materially less heat exchange in a cylinder the interior surfaces of which are highly polished.

If one could conceive the adiabatic expansion line for dry saturated steam as a standard and had an intelligent appreciation of the extent to and direction in which it is modified by each of these various causes, he would be able to get the most possible out of this feature of the diagram.

Faults in the Expansion Line

The most frequent fault in the expansion line is waviness due to spring vibration. In Fig. 2 the indicator piston has got stuck in its top position while the steam line was being made, and it was only after the pressure had dropped to *C* that it let go. Then it dropped so hard that it went by the true line, shown dotted, and only settled down upon it after several vibrations. A diagram with a perfectly straight steam line and a sharp cutoff, as at *A*, is very likely to have been made with an indicator having a sticking piston even when it does not show such an abrupt falling off and so much vibration.

Put your finger lightly on the pencil lever where the piston is attached and let it move with the piston. Any tendency to stick or any gritty or irregular action will be evident to the touch.

Diagrams from high-speed engines are particularly likely to be wavy. For this reason a stiffer spring may have to be used than on a more slowly running engine at the same pressure.

Each spring with the attached parts has a natural period of vibration. If this is some multiple of the number of impulses that it gets from the engine per unit of time—that is, if the steam pressure hits the indicator piston just as it is going up several times in succession—the amplitude of its vibration will be considerably increased.

The friction of its point on the paper has a considerable steadying effect upon the pencil. Diagrams made

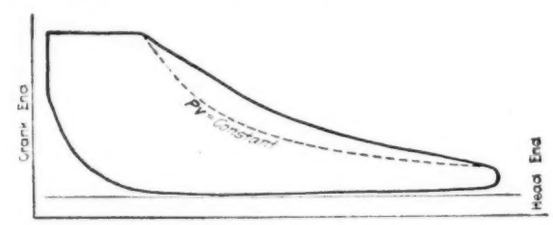


FIG. 5. LEAKY ADMISSION VALVE

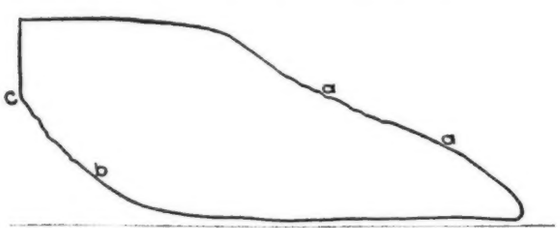


FIG. 6. ROUGH EXPANSION DUE TO GRIT

by shooting a stream of sparks from a Rumkoff coil between the pencil point and the drum show wavy expansion lines even on slow-running engines. Vibration may also be dampened by touching the pencil movement lightly with the finger, as previously described. The piston has a quarter of a pound of actuating force for each pound of pressure that it has to indicate, so that such light counterpressure as the pencil can exert even with its leverage, or as would be exerted by the finger, will have no measurable effect excepting with springs of the lower scales.

When an irregularity appears some way down upon the expansion line, notice if its commencement is not when some parts of the pencil movement are in line or likely to touch each other. It requires only a slight twang to set the pencil motion into vibration. Occasional puzzling irregularities in the expansion line all

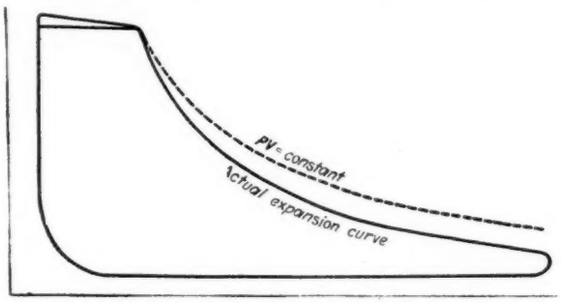


FIG. 7. LEAKY PISTON OR EXHAUST VALVE

the way from a simple wave like *bb* in Fig. 3 to an apparent explosion like *cc* have their cause in a contact of the pencil lever with some point, as shown in Fig. 4. When the expansion line runs noticeably above the $pv =$ constant line, as in Fig. 5, it suggests a leaky admission valve although, as has been explained, there may be other causes. Block the engine on the far center, close the exhaust valve on the end in question, and see if steam will escape from the open indicator cock. If so, the admission valve leaks. An indicator piston with considerable friction might cause it in addition to the causes previously mentioned. Friction, a scar or a small piece of grit on the indicator piston may make rough expansion and compression lines like Fig. 6, at *aa* and *cb*.

An expansion line that falls considerably below the $pv =$ constant line, as in Fig. 7, is evidence, although not proof, of a leak from the cylinder, probably through the exhaust valve or the piston. If this is the cause, the compression line should fall too. The more successful the designer has been in avoiding condensation and re-evaporation, the more the line will drop toward the adiabatic, but in this case the compression should rise all the more sharply. In the unaflow type of engine the expansion line may approach quite close to the adiabatic. When the expansion and compression curves both fall off, the exhaust valves and piston should be tested for tightness.

Conformity with the $pv =$ constant curve is no proof of tightness. An engine may be leaking in both admission and exhaust valves at such relative rates as to produce an apparently perfect expansion line.

Frequent estimates of oil and oil-shale reserves are made by engineers, laymen and others, which may be conservative or extravagant, according to the personality of the individual. Estimates by the Secretary of the Interior in his report for 1921, presumably gathered by unbiased officials, may be regarded as representing the best judgment of today. He estimates the amount of the nation's oil and oil shale supplies as follows: Crude oil, 7,000,000,000 bbl.; shale oil, 50,000,000,000 bbl. The Government has withdrawn from entry 128,267 acres of oil-shale land and 6,697,356 acres of potential oil land in the Western States.

Cutouts in Motor Circuits and Their Location

Where To Place Fuses or Circuit Breakers To Protect the Circuits on Which Motors or Other Electrical Devices Operate To Prevent Fire and Accident Hazards

By EDGAR P. SLACK
Assistant Electrical Engineer Underwriters' Laboratories

THE National Electrical Code rule specifying where cutouts shall be connected for the proper protection of the conductors of motor circuits reads as follows: "Each conductor carrying the current of only one motor and each ungrounded conductor carrying the current of a group of motors must be protected in

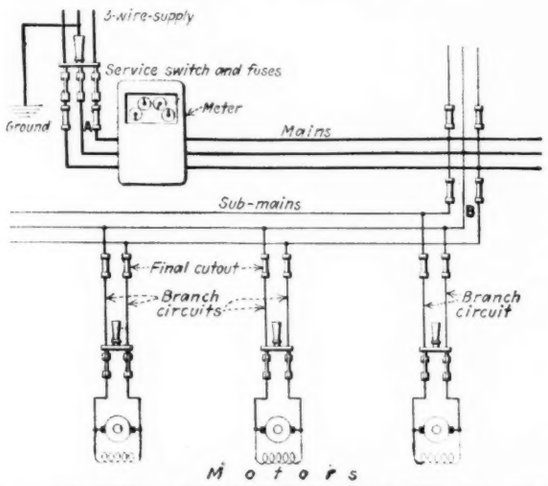


FIG. 1. PROPER ARRANGEMENT OF FUSES ON THREE-WIRE SYSTEM WITH GROUNDED NEUTRAL

accordance with the general requirements for the protection of conductors . . ." To illustrate the application of the rule, consider the following typical cases:

Figs. 1 and 2, which represent a grounded system and an ungrounded system respectively, each supplying a

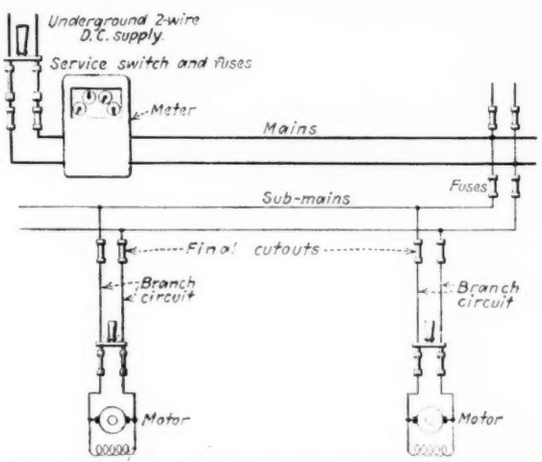


FIG. 2. PROPER ARRANGEMENT OF FUSES ON TWO-WIRE SYSTEM

group of motors, show the proper method of protecting the conductors in each case. Note that the final cutouts always protect each conductor of the branch circuits, for these conductors carry the current of only one motor. The mains and submains, however, carry the current of a group of motors, and where these circuits are fused—that is, at the service entrance and where the wire size changes—fuses are placed in ungrounded conductors only. For instance, in Fig. 1 the grounded wire is unfused at the service entrance *A* and also at *B*, even

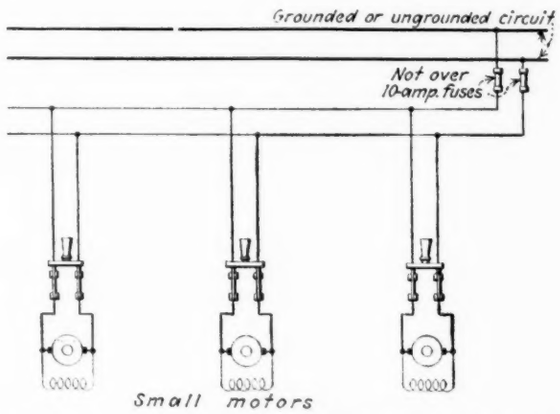


FIG. 3. CIRCUIT FUSED TO PROTECT A GROUP OF SMALL MOTORS

though the submains are of smaller size than the mains. In Fig. 2 all the conductors are ungrounded, and all are fused in compliance with the rule.

An exception is made in the case of small motors, which "may be grouped under the protection of a single set of fuses provided the rated capacity of the fuses does

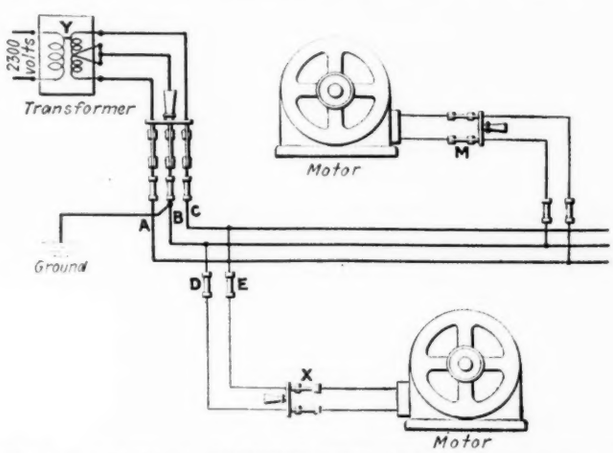


FIG. 4. DIAGRAM SHOWING HOW ACCIDENT OCCURRED ON A THREE-WIRE CIRCUIT SUPPLIED FROM A TRANSFORMER

not exceed 10 amperes, and the total wattage of the circuit does not exceed 660." In this case, illustrated by Fig. 3, the rule is generally interpreted as requiring both poles of the branch circuit to be fused whether on a grounded or an ungrounded system. In either Fig. 1 or Fig. 2, if the wire size changes at the motor switch, fuses will be required at this switch.

The object of requiring cutouts in the conductors is to protect the insulation from deterioration through long-continued overloads and to prevent melting, overheating or other damage from short-circuits. The object of omitting the fuse in the grounded conductor is more complex, and some of the most important reasons may be illustrated by the following examples. In each case it is assumed that the grounded conductor was fused, which is contrary to rule, and the disastrous results are

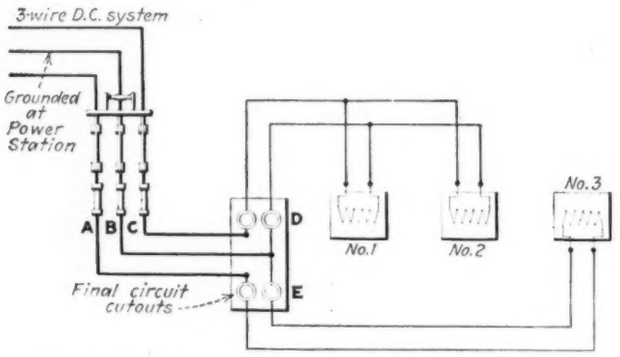


FIG. 5. IMPROPER FUSING OF THREE-WIRE CIRCUIT

recorded in the form of an imaginary report. It may be stated that actual reports of fires and accidents often show combinations of circumstances quite as remote as those pictured here.

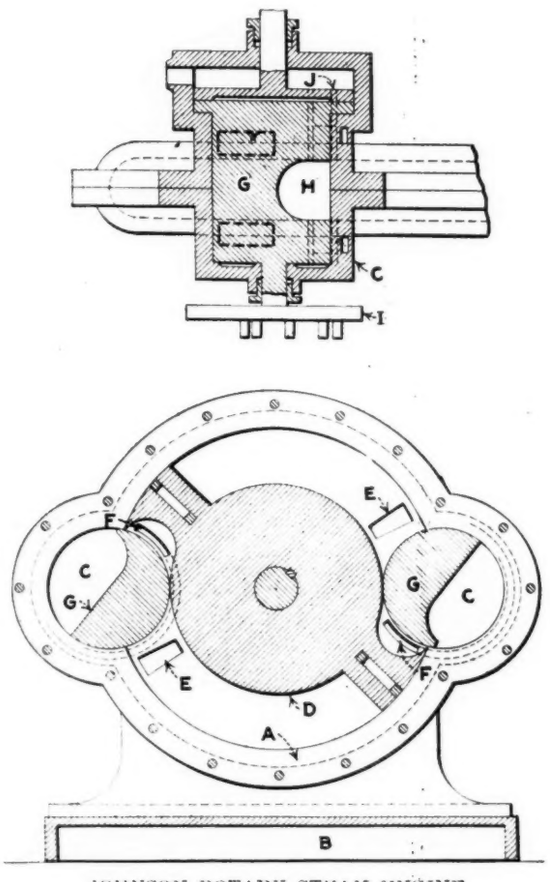
Case 1—Electrical Accident: This circuit, Fig. 4, is three-wire single-phase supplied from a 2,300- to 115-230-volt transformer, the neutral being grounded as shown. The grounded conductor was fused at *B* contrary to rule. Late in the afternoon a short-circuit occurred on switch *X* which blew the fuses *B*, *C*, *D* and *E*. The trouble was not repaired, and in the night, during an electrical storm, a breakdown occurred in the transformer at *Y*, between the primary and secondary coils. In the morning a workman replacing one of the fuses while in contact with a grounded pipe received a 2,300-volt shock and was killed. This accident would have been avoided if the grounded conductor had been solid instead of fused at *B*. The object of the ground is to prevent any part of the secondary system from attaining a potential to ground higher than that on the low-voltage side of the transformer. The blowing of the fuses *B* isolated this ground and allowed the secondary system to be raised to 2,300 volts when the transformer broke down.

Case 2—Fire of Electrical Origin: A small factory is supplied from a three-wire 110-220-volt direct-current circuit, Fig. 5, the neutral being grounded at the power station. The grounded conductor was fused at *B* contrary to the code rules. Three small 110-volt drying ovens were in use when an accidental short-circuit caused the neutral fuse at *B* to blow, the others remaining intact. The load was unbalanced, two ovens being connected to one side of the line and one to the other, and when the neutral fuse blew the voltage became unbalanced also, oven No. 3 receiving about one-third above its normal voltage. This oven became overheated and ignited the neighboring woodwork. If the grounded neutral had been solid instead of fused the fire would not have occurred.

These cases emphasize the importance of omitting the protective device from the grounded conductor. It might then be asked why should all wires in a grounded system including the grounded wire, be protected by cutouts at the final branch circuits, which are directly connected to lamps, motors, etc. Fusing all the lines at the final cutout is not open to the serious objections described in the foregoing. Referring to Case 1, it may be seen that the protective ground would not be lost by blowing fuse *D* only, in the grounded conductor. In Case 2 the blowing of a fuse in the grounded conductor of a final branch circuit, at *D* or *E*, would not cause unbalancing of the voltage, but would only cut one of the circuits off the line. Also, the final cutouts are those that blow most frequently, and a fuse in each line provides two to blow in series and makes the performance easier.

Rotary Steam Engine

Patents have been issued to Albert C. Johnson, of Stillwater, Minn., covering improvements and modifications in the rotary steam engine. The sketch shows the engine as constructed. The cylinder *A* rests on the engine base *B* and has formed upon its opposite sides extension *C* constituting valve cages. The cylinder has projecting through it the axis or shaft of the rotor *D*, which carries two lugs containing packing rings. The central portion of the rotor is provided with concentric grooves opposite similar grooves in the ends of the



JOHNSON ROTARY STEAM ENGINE

cylinder, and these grooves co-operate to form traps for water condensation or oil, which will fill the grooves and serve as a seal for preventing leakage of compressions from the interior of the cylinder to the slight space around the shaft at the end.

Formed in one wall of the cylinder, adjacent to the

cage *C*, are exhaust ports *E*, which lead to any suitable pipe or exhaust manifold. Inlet ports *F* are also formed in the walls of the cylinder. Within each of the valve cages *C* is a rotary valve *G*, supported on a stem that passes through one end of the cage. This valve has a portion *H* cut away, which permits of the passage of the rotor piston when in a certain position, and is provided at one end with a flange adapted to cover the adjacent inlet port *F*, and this flange is formed with a cutout portion of less length than the port *F*, but adapted to register at certain intervals. Carried on the stem of this valve is a disc *I*, having pin projections, which engages with an elliptical gear mounted on the end of the rotor.

The number of the pins and teeth in the elliptical gear is such that as the rotor revolves the valve is also constrained to revolve. This admits steam through the port *F* into the cylinder behind the pistons of the rotor, and owing to the eccentricity of the series of pin teeth and the elliptical formation of the gear, it will be seen that the valve *G* will not rotate at a uniform speed, but will rotate very rapidly throughout a portion of a revolution and will have its movement retarded during the remainder of the revolution, this retardation being necessary to permit the passage of the piston *D* through the cutout portion of the valve.

Inside each cage, engaging the flange of the valve, is a control disk *J*. This disk has a cut-out portion on its surface adapted to register with the cut-out portion of the steam-valve flange during the rotation of the valve, so as to control the admission of steam into the cylinder through the ports. Each disk carries a stem upon which is secured a crank arm, and these crank arms are connected by links to a vertical governor shaft.

If transformers are for operation at a comparatively low voltage, a satisfactory and simple method for determining moisture in the oil is to heat a small quantity of copper sulphate (blue vitrol) until it is perfectly dry. The dehydrated copper sulphate will be white. Place some of the oil in a test tube and add a small quantity of the dehydrated copper sulphate. If the oil contains moisture, the copper sulphate will return to its original blue color. It would not be advisable to depend upon this test for determining moisture where the transformers are for operation on voltages over 6,600 volts.

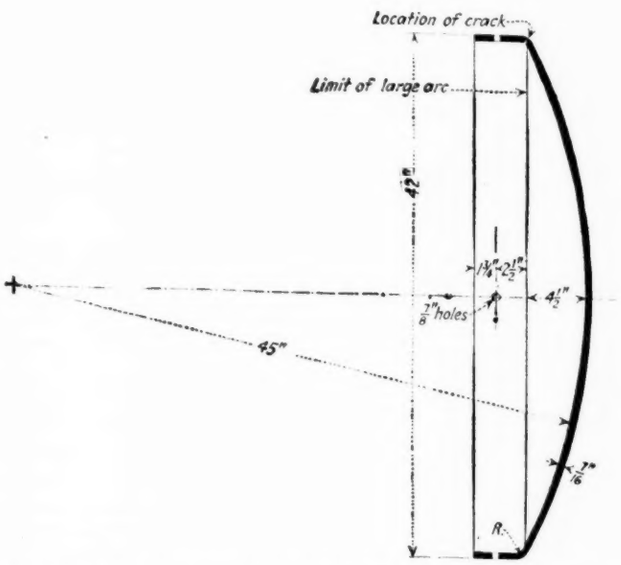
It has been found that little if any corrosion of iron pipe carrying water will occur if the rate of flow is over 700 ft. per min. This high velocity has the effect of washing away the solution of ferrous hydroxide which is held to be responsible for iron-pipe corrosion. Dr. Norton Friend of Birmingham, England, reports that the corrosive action of water decreases in direct proportion to the alcoholic content of the liquid. He holds the corrosion is due to the inhibitive effect of alcohol on colloids.

All gage glasses are keenly susceptible to surface abrasions, even so minute as to be unobservable. If one receives the slightest scratch inside or out, it should not be used, and in handling or keeping them in stock, no metal of any nature should be allowed to come in contact with them. They are particularly likely to break if iron or steel touches them, and so should never be laid down even temporarily with tools, as is frequently done in preparation for a renewal.—*The Locomotive.*

Further Data on Boiler Failure at Springfield Armory

Power has received the following additional particulars regarding the dished head that failed on a drum of one of the boilers at the Springfield Armory (described in *Power*, Feb. 7, 1922).

The head was dished to a radius of 45 in. and joined the small curvature ($R = 1\frac{1}{2}$ in.) at the heel on a tangent, as shown in the accompanying sketch. The diameter of the drum was 42 in. The Massachusetts



SKETCH OF DEFECTIVE BOILER HEAD AT SPRINGFIELD ARMORY

rules do not allow a head to go without bracing when dished to a radius greater than its diameter.

The Boiler Code of the A. S. M. E. gives the following as the thickness required in an unstayed dished head with the pressure on the concave side:

$$t = \frac{5.5 \times P \times R}{2 \times TS} + \frac{1}{8}$$

The Massachusetts Boiler Rules call for the following thickness:

$$t = \frac{8.33 \times P \times R}{2 \times TS}$$

In the formulas t is the thickness of head in inches, P is the allowable working pressure, R is the radius to which head is dished, and TS is the tensile strength of head.

By both Code and Rules the tensile strength is taken at 55,000 lb. per sq.in. for purposes of design and the determination of the allowable working pressure. The boiler was designed for 175 lb. but ran at 150.

The required thickness computed from the foregoing rules is as follows:

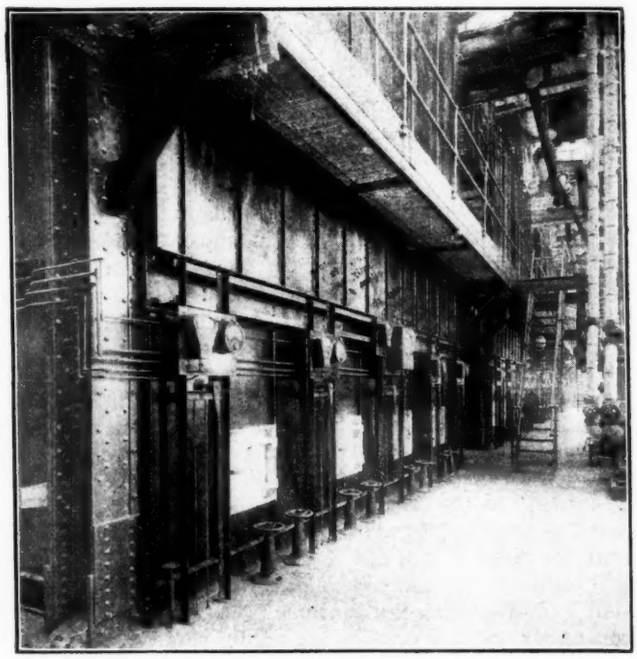
	Pressure 175 lb.	Pressure 150 lb.
A.S.M.E. Code	0.519	0.462
Mass. Rules	0.596	0.511

The actual thickness was $\frac{7}{16}$ in., or 0.4375.

There was no manhole or other opening in the head except a 2-in. tapped opening for the blowoff. This is visible in the photograph shown on page 206 of the Feb. 7, 1922, issue of *Power*.

Present-Day Boiler-Room Operation*

BY I. E. MOULTROP AND R. E. DILLON



Eight times the output per square foot of heating surface, twice the output per pound of coal, twenty per cent increase in regular operating efficiency of the boiler and twenty times the output per man in the fireroom represents the advance in boiler practice in large stations during the last ten or fifteen years. To secure this requires attention to design, combustion efficiency and economical loading of turbines and boilers. The article tells how the last is attained.

THERE is no part of a steam-generating power plant where scientific methods can be better employed than in the boiler room. Within recent years extraordinary advances have been made in the design of more efficient apparatus. Various meters and measuring devices have been developed, and analytic methods come into use for regulation and control.

We can all point to equipment in operation today that bears a very unfavorable comparison with modern-built apparatus in the matter of efficiency. Much of the equipment, however, represented the last word in efficient design at the time of its installation. I have in mind an electric-light plant built in the year 1899. Its capacity was 10,400 kw. in engine-driven units. The largest of these was 1,600 kw., and this required one oiler and two firemen. A modern station is operated with one oiler and one fireman for each unit of 30,000 kw. or larger. The output per man is, therefore, twenty times as much in the modern station as in the older one.

*A paper read by Mr. Moultrop before the Metropolitan Sections of the A.S.M.E. and A.I.E.E. at New York, Feb. 24, 1922. The authors are, respectively, Asst. Supt. of Construction and Asst. Supt. of Generation, Edison Elec. Ill. Co. of Boston.

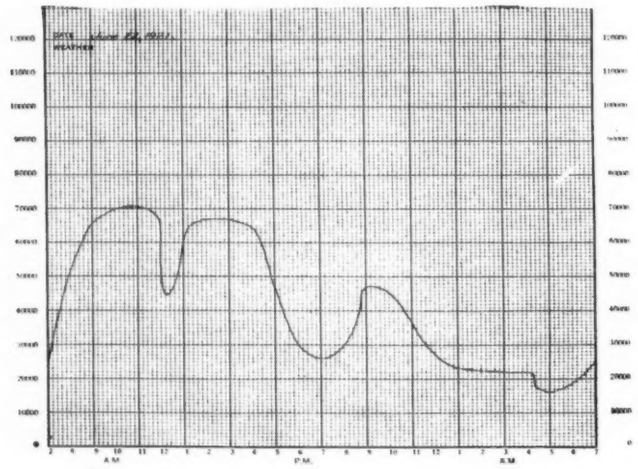


FIG. 1. TYPICAL SUMMER [illegible] LOAD CURVE

Furthermore, 2.55 lb. of coal, or 37,000 B.t.u., are required in the old engine-driven plant to produce one kilowatt-hour; in the modern station this is accomplished with 1.25 lb. of coal, or 18,100 B.t.u.

Large-capacity boilers equipped with modern types of furnaces such as are going into so many plants today have an efficiency of 80 to 85 per cent at the operating point of loading, which is a gain of 15 to 20 per cent over types installed ten years ago. The modern furnace and boiler is capable of being forced over peaks to a very much greater extent than the older installations, and for this reason, where the character of the load curve permits it, a great saving can be made over the practice of carrying banked boilers.

Another factor worth noting is the improvement in maximum load that can be supplied by a given number of boilers. In a plant built in 1905, the ratio of maximum load to capacity of boilers was 1 kw. per 10 sq.ft. of boiler-heating surface installed; today it is 8 kw.

EFFICIENCY-LOAD CURVE

The character of the daily load curve has an important bearing on operation. Obviously, if the load curve is flat and without peaks, it will pay to operate the boilers at as near the point of maximum efficiency as is consistent with good operation and labor conditions and as the capacity of the plant will permit. If there are peaks in the load curve, however, the degree of forcing over these peaks and the amount of banking to provide for them will depend on various considerations as will be shown later.

A daily summer load curve typical of a central-station power plant is shown in Fig. 1. That in Fig. 2 is typical of the average winter day. It shows the peak which comes on when the power load overlaps the lighting load.

No set rule of operation can be established to fit all plants. Consequently, the curves and data shown apply to particular installations. The method to be explained, however, is general. The highest point of efficiency of the particular boiler and fuel-burning equipment represented by Fig. 3, is at a low rating, and the efficiency falls with increasing rapidity toward

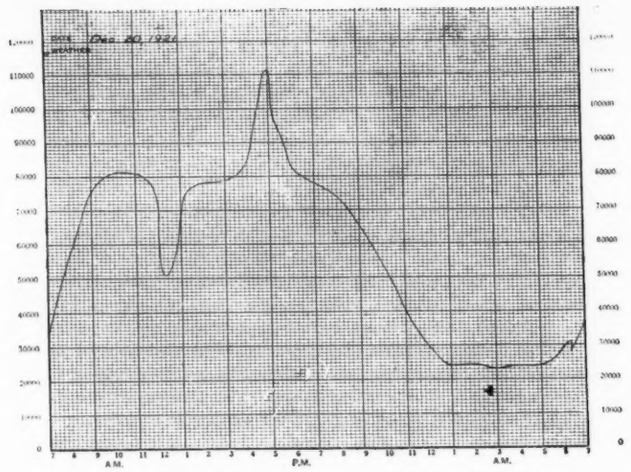


FIG. 2. TYPICAL WINTER DAILY LOAD CURVE

the higher ratings. Nevertheless, other considerations make it undesirable to operate at the highest point of efficiency shown on the curve over the long periods of the day load. With modern equipment no appreciable gain in labor can be made by operating at higher rating, since one fireman can take care of a row of several boilers and the lighting of additional boilers will not increase the labor appreciably. However, some types of older equipment of small capacity require one fireman for a small number of boilers and the increase of labor with additional boilers is an important item.

Furthermore, it is usually found difficult to operate at the lower ratings for any length of time without burning holes in the fires. Experience and a due consideration of these factors proved in this particular installation that some higher degree of forcing was the best point for operating on the day load.

The question now arises whether to force the boilers over the peak or bank additional boilers for it. The duration of the peak enters into this, and the type of equipment determines how long a given high rate of forcing can be maintained without difficulty in keeping

NORMAL FORCING 150 PER CENT

1 Boiler at 300	per cent extra coal	835 ×	1 =	835
2 Boilers at 225	per cent extra coal	265 ×	2 =	530
3 Boilers at 200	per cent extra coal	140 ×	3 =	420
4 Boilers at 187.5	per cent extra coal	90 ×	4 =	360
5 Boilers at 180	per cent extra coal	67 ×	5 =	335
6 Boilers at 175	per cent extra coal	55 ×	6 =	330
10 Boilers at 165	per cent extra coal	30 ×	10 =	300

Each case takes on additional load of 1 boiler at 150 per cent.

the fires in condition. Much higher rates can be employed for short periods than would be practical for longer ones. Furthermore, the extent of high forcing and the period used affect the maintenance costs, which mount rapidly with the high rates and also the time so used.

There is a point at which the loss due to extra fuel burned by forcing at a high rate over a peak is equivalent to the loss due to the alternate case of carrying additional boilers for this peak. An example will illustrate the importance of finding this point:

Suppose that 150 per cent rating has been demonstrated to be the most efficient and practical for operation through the day. By forcing all boilers over the peak to a higher rate, the plant may be run with less boilers banked while operating on the day and night loads, thus saving banking losses. The table gives the loss in pounds of coal caused by forcing different combinations of boilers above their economical rating in order to carry for one hour the load that would be economical for this combination plus one more boiler. Fig. 4 shows the results of the table extended to cover losses for several hours of forcing. In the same view is shown a line that represents the banking coal saved by cutting out one boiler for the remainder of the 24 hours. Where the banking line crosses the forcing line is the point at which saving is offset by loss for any combination.

Plotting the forcing hours against per cent forcing for these points of intersection gives the curve shown in Fig. 5. This curve shows the limit of forcing beyond which the losses are greater than the gains. It shows that for the higher rates of forcing short periods only are economical and for low rates of forcing long periods are practical.

The rate at which savings decrease as the period of forcing is increased is shown well in Fig. 4. Here the horizontal line through the hours of forcing subtended by the angle between the forcing curve and the banking curve represents the saving corresponding to any combination and period. As the hours of forcing are increased the line subtended becomes shorter rapidly, and this effect is more pronounced in the more obtuse angles of the higher rates of forcing.

Method of Operating

The boiler-room foreman is responsible for having a sufficient number of boilers lighted to take care of the daily peak and the proper number steaming to give best efficiency at all times, determined as previously described. He authorizes the number of boilers to be brought into steaming or to be taken out to take care

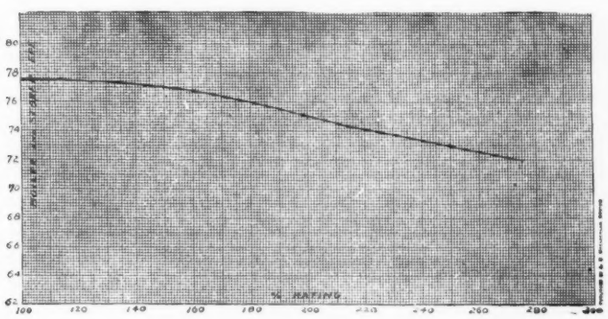


FIG. 3. EFFICIENCY DECREASES WITH FORCING

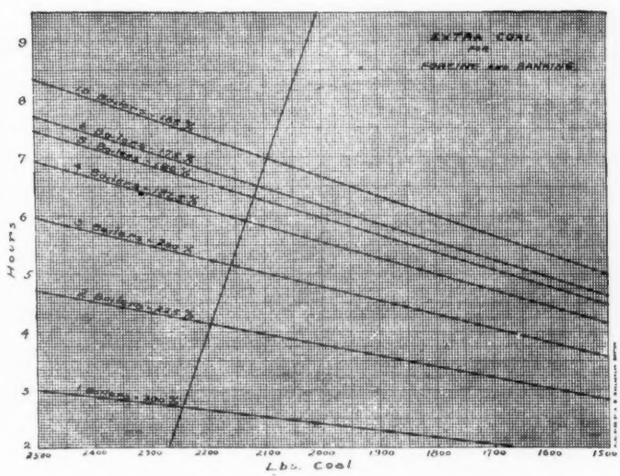


FIG. 4. SHOWS EXTRA COAL FOR FORCING AND BANKING

of the load which is indicated on a load sign located in the room.

Here the fireman's duty begins. With the knowledge of the load to be carried and the number of boilers to have steaming to carry this load, he refers to a curve that indicates how much coal he must burn in each furnace to produce the necessary steam. He looks at the tachometers, which are scaled in pounds of coal being fed, and adjusts the coal feed by means of the rheostat on the stoker motors until the tachometers indicate the proper amount for the output. The tachometers are provided with secondary scales which indicate the approximate air pressure to be maintained in order to supply the right amount of excess air to burn the coal.

He next adjusts the damper or, if induced-draft fans are in service, he regulates this to bring the draft over the fire, as indicated by draft gages for this purpose, to a slight vacuum, usually about one-tenth inch. Pressure instead of draft would be better over the fire for reasons of efficiency since it would overcome any tendency toward infiltration, but on account of the danger of blowing out through the doors when they are opened and also as an aid in maintaining the furnace walls, a slight vacuum proves better.

The fireman next looks at the steam-flow meter to see if the proper amount of steam is being produced, and if this proves to be the case he looks at the steam gage to see if the pressure is maintained. If the steam flow or pressure indications are unsatisfactory, he takes steps to correct this, keeping in mind the adage, "Service first—efficiency second." After the steam flow and pressure are made satisfactory, he turns his attention to the CO_2 recorder or air-flow indicator to make sure that the right amount of excess air is being used.

Co-ordination

In striving after high efficiency in the boiler room, due consideration must be given to co-ordination with other parts of the plant. The efficiency figures in this part of the plant alone should not serve as a criterion for judging the good work of the fireman and the design of the plant. It is the efficiency of the boiler room and turbine room in conjunction which tells the final story.

Too often it is thought that the measure of efficiency is the loss to the ashpit and up the stack. This will not prove to be the case until this loss is weighted against the loss of heat to the circulating water in the condenser. Feed water can be heated throughout the greater part of the temperature range from either of these two sources of heat. However, by utilizing some of the heat that would otherwise go to waste in the circulating water, the turbine room gets the credit rather than the boiler room, and provided this credit outbalances the loss in the boiler room, the case is justified.

Rapid Change in Load

During the day, if there is a sudden increase of load, the boilers are in a position to pick it up quickly and can be forced for short periods to high rates without regard to economy. If there are banked boilers, as in winter time, these can be brought in if necessary.

Rapid change in conditions at about seven o'clock in the morning on the average lighting-company system is a problem that often proves difficult to handle. If the company is not tied in with other plants, only the ordinary increase of the morning load has to be absorbed and the case is simple. However, if the company is tied in with a water-power interconnection, the problem becomes harder to meet.

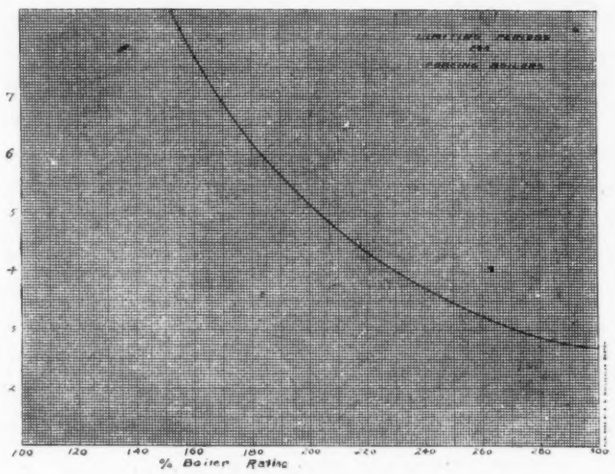


FIG. 5. LIMITING PERIODS FOR FORCING

Emergency Conditions

Schedule peaks and peaks that occur regularly are taken care of by forcing steaming boilers or by holding boilers in bank. Frequently, however, an emergency peak is thrown on the system sometimes with warning enough for a few minutes preparations to meet it and sometimes with no warning whatever.

Thunderstorms can usually be discounted ten or twenty minutes ahead and hot banks prepared and fire and air pressure built up in the steaming boilers. In cases like this there need be no disturbance in absorbing the load, and it can be done with slight decrease in efficiency.

However, it is the sudden increase or decrease in load which occurs without any warning that taxes the boiler room hardest and impairs efficiency most.

Light, Space and Cleanliness

The story of present-day boiler-room operation would not be complete without a word about conditions under which the men have to work in the boiler room. In modern plants it is established practice to spare no expense in making conditions safe and eliminating accident hazards, providing plenty of light everywhere around machinery and plenty of space and keeping the stations clean. The additional expense that has been put into stations to improve conditions has given a high return on investment, and this factor alone has contributed in a great degree toward efficiency.

The curves shown were worked up from actual operating data by G. R. Davison, of the Generating Department of the Edison Electric Illuminating Company of Boston.

India has a total installed capacity of over 215,000 kw. of electrical generating machinery. Of this amount steam power produces 129,000 kw., internal-combustion engines 8,000 kw., and waterwheels 78,000 kw. About 130,000 kw. of this power is produced by central stations, 80,000 by private generating plants and the remainder by electric railway plants. It is estimated that India has enough water power to allow of continuous production of over one and one-half million horsepower.

Turbine Accident at Edison's Plant

On Sunday, Feb. 19, an accident occured to a 2,000-kw. turbine in the generating station of the Thomas A. Edison Co., West Orange, N. J. The turbine was a horizontal single-drum Curtis type, fitted with three two-stage wheels of cast-steel construction and operated at 3,600 r.p.m. It had been in service for about ten years, although only since August, 1921, at the Edison plant. It was being operated on intermittent service supplying current to rotary converters in a substation in another section of the works, which is also supplied with current from the Public Service system.

The accident occurred at 12:25 a. m. a few minutes previous to the time for the turbine to be shut down. The engineer reports that the 500-kw. d.c. engine-driven unit, through the rotary converters.

The accident occurred at 12:25 a. m., a few minutes previous to the time for the turbine to be shut down. The engineer reports that the 500-kw. d.c. engine-driven unit was being brought up to speed and that the operator was already at the switchboard preparing to put the unit on the load in place of the turbine and rotary converter, when suddenly the turbine and the converter in the substation were heard to increase in speed. Before either the operator or engineer realized what was happening, the failure of the turbine occurred.

The rim of the third wheel, which was approximately 44 in. in diameter, was completely torn away, leaving the center of the disc at a diameter of about 23 inches. The fragments completely wrecked the low-pressure casing and the inlet to the jet condenser. No serious damage was done to the building or other equipment except the breaking of a reach rod and bracket of the valve gear on a vertical compound engine.

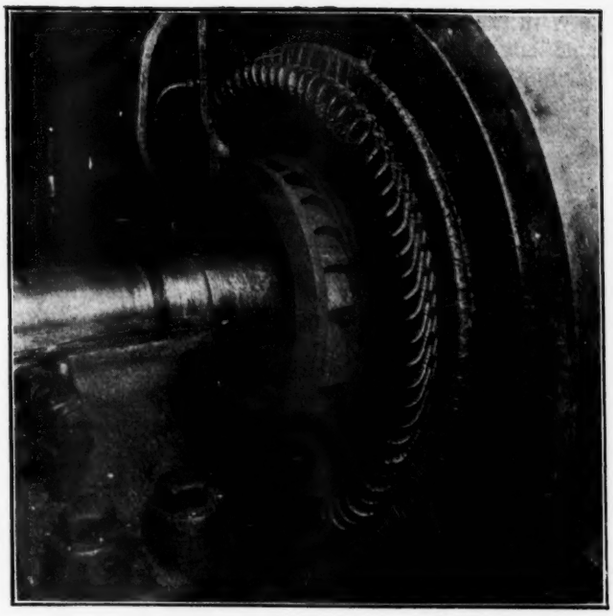
Fortunately, there were no serious injuries to either of the operators although one was on the gallery of the vertical unit close by and almost in line with the ruptured wheel.

Upon investigation immediately after the failure, the controlling valves of the turbine were found closed as was also the stop valve, which was tested and found to be in good operating condition. The overspeed trip pin in the rotor shaft and also the trip latch gave evidence of hammering from overspeed. This emergency trip had been inspected by an insurance representative as recent as Feb. 13, when the trip operated satisfactorily at 3,900 r.p.m. The governor was completely wrecked due to overspeed. The other discs of the rotor were undamaged except for the loss of four short pieces of shroud ring. The fans on each end of the generator rotor were badly distorted from excessive centrifugal stresses, as shown in the illustration.

According to the operator in charge of the station at the time, no steam escaped from the turbine when the accident occurred. This would indicate that the steam had been completely shut off. Also, from the fact that the bearing linings were undamaged it is evident that the governor and oil-pump drive did not fail until the instant the turbine let go.

The rotary converter in the substation was heard to increase in speed, and the overspeed trip with which this converter is equipped was found to have operated. This overspeed, device has since been tested up to 13 per cent overspeed, without operating.

In discussing the accident with the operators, the evidence secured was somewhat conflicting, and the absence of recording instruments makes it difficult to arrive at a definite conclusion as to the real cause of the overspeeding. There is a possibility, however, that this unit could have been motorized through the rotary converter being inverted. If the d.c. generator had been thrown in at the time it might have caused a reversal of power between the units.



SHOWS DISTORTED FAN ON GENERATOR ROTOR

Stratton Air-Flow Meter

An air-flow meter has recently been developed, which has a possible application in the boiler room in connection with forced-draft stokers of the underfeed type. It should be particularly applicable to the chain grate, with which it is especially desirable to know the quantity of air delivered to the different zones. With the aid of such an instrument the operator would be better able to determine and maintain the proper flow of air for different load conditions.

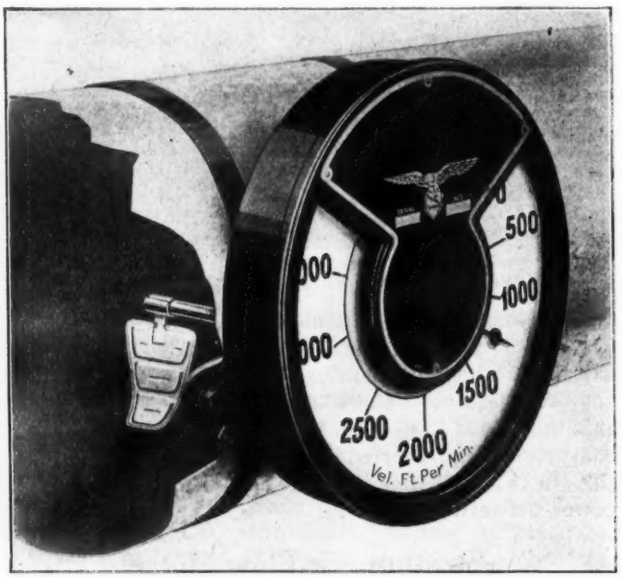
The meter is operated by a little vane that hangs in the middle of the pipe, as shown in the illustration. This vane may swing through an angle of 42 deg., according to the velocity of the flow, and in this way may turn a shaft that has a pulley on its end. The pulley is connected by a silk fishline to a smaller pulley, which is on the same shaft with the pointer of the instrument. The movement of the vane is resisted by a calibrated spring connected to the vane shaft through a cam so constructed that the pull on the spring increases as the square of the velocity of the air in the duct.

While the vane swings through its maximum travel of 42 deg., the dial hand swings through 284 deg., so that the vane movement is magnified nearly seven times. In this way, of course, the indications of the pointer are easily read, while the small movement of the vane allows practically its full surface to be presented to the velocity pressure of the air current all the way from zero to full scale.

Stuffing boxes are eliminated by arranging to screw the cover down on a gasket and allowing the pressure in the duct to act upon the interior of the instrument.

With the meter is furnished a pressure gage of suitable length to conform to mercury, water or oil column reading. When installed with the pressure gage, the meter must be set vertical, but if installed without it, the device may be set up in any position on the air duct that is convenient.

The one instrument will indicate velocities from 350 ft. per min. up to 2,000 ft. per min., or it may be arranged to read from 1,200 ft. to 6,000 ft. per min. The dial may, of course, be calibrated in any way required by conditions; for instance, it may indicate cubic feet or pounds of air per minute, or it may indicate



THE AIR-FLOW METER AS INSTALLED

The pointer moves seven times as far, in degrees, as the little vane in the middle of the pipe and indicates the velocity of air flow.

relative points of duty of air flow in pounds of coal consumed in the furnace, pounds of coke burned in a cupola, pounds of pulp dried in a dryer, etc.

The instrument has been designed and perfected by the Stratton Engineering Laboratories, of Chicago, Ill.

Transformer Connections for Power-Factor Meter

BY VICTOR H. TODD

Wishing to measure the power factor of a three-phase 4,000-volt circuit, I began to take stock of what was available to do it with, and found a three-phase double-scale Westinghouse meter and three 2,000-volt to 100-volt potential transformers, but the instructions called for two 4,000 to 100-volt transformers. After a little study it was decided to use the three transformers by connecting the primaries in star and the secondaries in delta, as in Fig. 2, and shifting the pointer back 30 deg. The connections for the power-factor meter with two transformers are shown in the diagram, Fig. 1. With this connection the current lags behind the voltage on posts 1 and 2 by 30 deg. when the line power factor is 100 per cent. But in the diagram, Fig. 2, using the star-delta connection, the current is in phase with the voltage on posts 1 and 2. Since the pointer was adjusted to read 100 per cent power factor with 30-deg. phase displacement, it follows that with the second connection the pointer will read 30 deg., or 86.6 per cent power-factor leading, thus necessitating that the pointer be set back 30 deg. so it again reads 100 per cent power factor when the line current is in step with the voltage.

When connecting up the instrument, it may read lag instead of lead owing to wrong phase rotation. In this

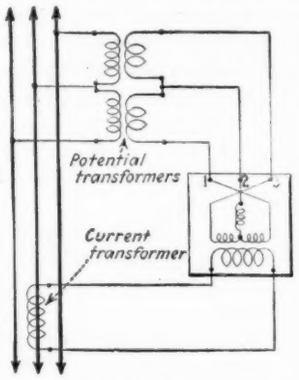


FIG. 1. POWER-FACTOR METER CONNECTED TO TWO TRANSFORMERS

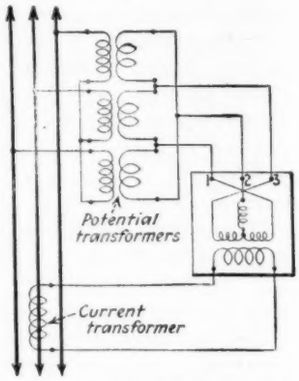


FIG. 2. POWER-FACTOR METER CONNECTED TO THREE TRANSFORMERS

case reverse any two wires on the potential posts *1*, *2* and *3*. Then there are six positions in which the pointer may rest when the line power factor is 100 per cent. If the pointer comes to rest at 50 per cent lead or lag on the lower half, then spiral the leads until it reads 100 per cent; that is, change connections on the upper posts by moving *1* to *2*, then *2* to *3* and *3* to *1*. If the instrument reads 50 per cent lead or lag in the upper half, then spiral the leads until it reads 100 in the lower half and reverse the current leads to make it read 100 in the upper half.

With the original transformer connections using two 4,000- to 100-volt transformers, the voltage on the meter was 100 volts. When three 2,000- to 100-volt transformers connected star-delta were used, the voltage was 115 volts. However, this will not seriously affect the

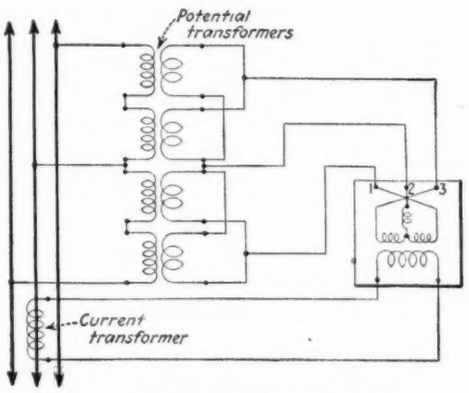


FIG. 3. POWER-FACTOR METER CONNECTED TO FOUR TRANSFORMERS

accuracy of the instrument, since this type of meter is designed to operate on from 90 to 130 volts.

Another method of using 2,000- to 100-volt transformers would be to secure another transformer, making four in all, and connecting the primaries in series and open-delta and the secondaries in parallel and open-delta, as in Fig. 3. The meter will now operate exactly as if two 4,000- to 100-volt transformers were used.

EDITORIALS

Dished or Bumped Heads

THE cracking of a dished head on the steam drum of one of the boilers at the Springfield Armory, described in *Power* of January 7, and under discussion in our correspondence columns, is an instructive exhibit in a subject now up for consideration by authorities on boiler design.

The head cracked in the usual way at the heel of the flange. The radius to which it was dished was 45 inches. It was $\frac{7}{16}$ inch thick; 0.074 and 0.025 thinner than the Massachusetts Rules and the A. S. M. E. Code respectively would have called for. The Massachusetts Rules, however, do not allow a head to go unbraced when dished to a radius greater than its diameter.

The flexure which resulted in the cracking of the head was apparently due to the sharpness of the bend at the flange rather than to inadequate thickness. The Code requires that the radius of the bend, measured on the inside of the head shall be not less than $1\frac{1}{2}$ in.; the Massachusetts Rules that it shall be not less than three times the thickness of the head, which in this case would have been $1\frac{5}{16}$ in. In this case it was only $1\frac{1}{16}$ in., about 30 per cent less than the Code requirement.

The steel used was of high tensile strength, 64,000 lb., 65,000 being the high allowable limit, and had, on tests of two samples taken from near the crack, 0.25 and 0.26 per cent carbon. The limit in both Code and Rules is 0.12 to 0.25 for fire-box steel with no limit for flange. Massachusetts does not permit the use of flange steel.

If the departures from the authorized practice in this case were enough to induce failure, the framers of codes and rules are skating close to the edge. The treatment of the material in its fabrication is of more moment than either, and the indications are that the treatment to which this head had been subjected was not of the best.

Our knowledge of the action of an unstayed dished head under pressure is far from complete, and much remains to be determined with regard to the best material, thickness, shape and method of fabrication to resist destructive deformation under varying pressure. Its application in design embraces much more than boiler practice. A conclusive experimental research would be of wide benefit and could be made at moderate expense. We suggest it as a subject to those having research laboratories at their command.

Crossing the CO Danger Line

IN AN ARTICLE entitled "Keeping Down the Furnace Losses," in this issue, Professor R. T. Haslam discusses the flue losses in an interesting manner. What is more important from the practical standpoint, he gives diagrams that make it easy to determine the size of these losses from the flue-gas analysis without knowing the composition of the fuel.

The method given is reliable and easily applied, the only operation of appreciable difficulty being the analysis of the flue gas. For this the operator must have, and be able to use, an "Orsat" equipped for the determination of CO_2, oxygen and CO. Fortunately, it takes only a little practice to learn to make an accurate and complete analysis in fifteen minutes. A few boiler tests with such analyses are sufficient to show what percentage of excess air gives the smallest total flue loss for the given furnace and fuel. The corresponding amount of CO_2 can then be noted and used as a guide for future operation.

Professor Haslam's statement that some CO is always present at the point of best efficiency may come as a surprise to many, but there seems to be no escape from his logic. However, it should be noted that in practice the operator cannot hold the excess air exactly at a certain point. The best he can do is to maintain a certain average of excess air. This fact must be taken into account. If, for example, the best efficiency is obtained with twenty-five per cent of excess air, it does not necessarily follow that twenty-five per cent is the best point for the average excess air. The average involves swings above and below twenty-five per cent. A given reduction below twenty-five per cent does far more damage than an equal increase. The reason for this is found in the sudden jump in the CO loss when the excess air is cut down below a certain point.

The logical conclusion is that, if twenty-five per cent is the best point for constant excess air, a somewhat higher percentage is best for the average, in cases where the amount of excess air fluctuates. The greater the fluctuations the higher should be the average percentage of excess air. Another lesson to be learned is that fluctuations in the amount of excess air mean loss of efficiency, even though a good average is maintained.

International Exposition

THE international exposition, for some time out of vogue, is with us again in the making. For a time there was a plethora of them. Some body, or group of bodies, seemed to be studying history with a view of finding something to celebrate. France was running a series, commenced in 1867 and spaced eleven years apart, to enable her to come out square with 1900, which was her last great demonstration of this kind.

Since the Pan-American Exposition in San Francisco in 1914 there has been no great demonstration of this kind to engage the attention of American arts and industries. The one hundred and fiftieth anniversary of the signing of the Declaration of Independence will be made the occasion of the next great American Exposition. This will appropriately be held in Philadelphia, and the participation of the World will be invited. The Engineers' Club is taking an active part in the selection of a site, which is likely to include that of the Centennial Exposition of 1876. An effort will be made to have the exhibits comparatively illustrative of products and practices then and now.

In the meantime France has resumed her old activity and is planning for an exposition of her colonies and

allied powers at Paris in 1925 under the title l'Exposition Coloniale Interalliée de Paris. Its organization is to be under the direction of the Ministers of the Colonies, the Interior, Foreign Affairs and of Commerce; the Municipal Council of Paris, and the Council General of the Seine; of the French Committee of Expositions and of the National Committee of Colonial Expositions. The City of Paris has put at the disposal of the organizers the Esplanada des Invalides with the quais and banks of the Seine, the Alexandre III and Iéna bridges, the southern portion of the Gardens of the Trocadéro, those of the Eiffel Tower and what remains available of the Champ-de-Mars, this, which was largely the site of the Exposition of 1900, constituting the nucleus of the Exposition, while the principal exhibits will be located at the Bois de Vincennes.

Carried out upon a high plane, with a real display of products and a real exemplification of the processes and practices used in their production, the international exposition is a stepping stone in industrial progress, inspirational, educational and beneficent. Success to both projects!

Application of Synchronous Motors

SYNCHRONOUS motors are rapidly coming into favor for many applications, and as the electrical manufacturers improve the characteristics of this class of motor its field of application is being widened. As more attention is given to the question of better power factor, the demands for the synchronous motors will increase greatly beyond what they now are. Even at present the installation of such equipment has reached considerable proportions. One large electrical manufacturer reports that last year approximately ten per cent of his alternating-current motor sales were of the synchronous type. Where a few years ago it was not considered advisable to build these motors in sizes of less than two hundred or three hundred horsepower, today they are listed down to seventy-five horsepower.

Many of the duties performed by motors today are possible only by a motor and control especially developed for this service. Now what is true of motor applications in general is equally true of synchronous motors. A synchronous motor that may give excellent service in one application might be an absolute failure in another. Synchronous machines are in general of large size and the expense involved in their installation is considerable, and if a mistake is made in the motor's application it will undoubtedly be costly.

As far as the actual operation of the motor is concerned, the problem of a successful synchronous motor may be said to involve stable operation and the necessary torque to start the load and pull it into step. With the average motor, outside of the synchronous type, any load it can start it can generally bring up to normal speed. This, however, is not the case with the synchronous machine.

Although much has been done to improve the starting characteristics of the synchronous motor, the machine that can develop both good starting and pull-in torque is yet to be produced. A motor designed for good pull-in torque will have a comparatively low starting torque, or if designed for good starting torque its pull-in torque will be reduced. On the other hand, a motor that might give satisfactory operation driving a generator, centrifugal pump or fan, might fall down badly if applied to some type of reciprocating machine, such as a compressor. Whereas only a comparatively small flywheel effect is sufficient to give stability in the former, a heavy flywheel is required in the latter, and the weight of flywheel will vary with the type of compressor. A motor designed for unity power-factor operation would be not suitable to application of a combination of mechanical load and power-factor correction.

There is no class of motor that requires any closer co-operation between the user and the manufacturer than does the synchronous type. This type of machine, when properly applied, is capable of giving excellent service and correcting the bad effects of the induction motor on the system besides. However, if the full benefit of its characteristics are to be obtained, the user and manufacturer must see to it that the proper type of motor is installed. Only by co-operation between the two can misapplication and unsatisfactory service be avoided.

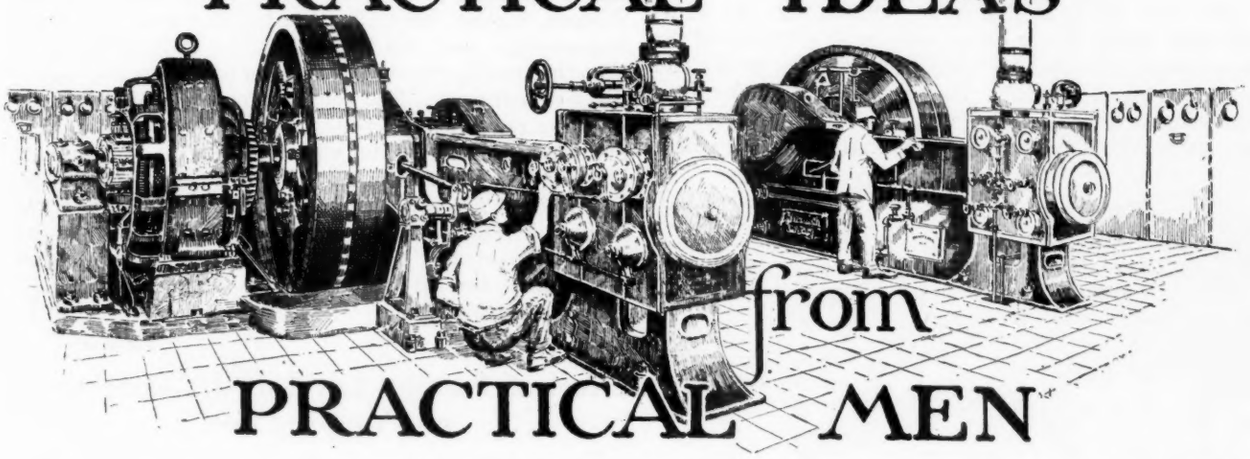
The small boy with an endless sense of curiosity is a pest, but what good is a repair or maintenance man, for instance, if he is not inquisitive? How many times does he have to put in a new fuse before he begins to wonder what made the other one burn out? How often does he have to doctor a bearing before he begins to wonder why it does not last longer? How many times does he have to replace a worn part without asking himself whether there isn't some way of making it stand up better? Of course, if he just wonders, he will get no results, but if he goes after these questions and finds the answers, he will realize that curiosity kills repair bills. Many chances of stopping waste and improving methods may be found, with the aid of an inquisitive nature, that would never come to light in an atmosphere of contentment. It is the same quality that has made possible practically all great inventions. What else could have led Newton to investigate the law of gravity after the apple landed on his head? It is no less valuable in personal advancement. Without it the student gets little benefit from his lessons, the fireman remains a fireman and the engineer sees new chiefs come and go without getting a chance at the job himself.

An uninsulated steam line creates no disturbance to call attention to it, but all the time it is wasting heat at a rate that would pay in a very short time for proper covering. We must tolerate large heat losses up the stack and in the cooling water from the condensers with our present methods of converting the heat in the coal into electrical power at the terminals of the generator. But, with hot steam heated surfaces it is different; not only is there a means at hand to prevent these losses, but this means will pay big dividends when properly applied.

To burn coal efficiently in a boiler is essential, but this is only half the boiler-room problem, as will be evident from a perusal of Mr. Moultrop's paper in this issue. Intelligent load dispatching in the boiler room is not alone a subject for central-station operation, but is also one warranting study by those responsible for power generation in all large industrial plants.

The supplement to the Feb. 28 issue, giving hyperbolic curves for use with indicator diagrams, was inadvertently printed on too heavy paper. This can be made transparent, however, to serve the intended purpose by soaking in oil.

PRACTICAL IDEAS from PRACTICAL MEN



Loose Counterweight Caused Pound

Some time ago I had occasion to hunt for a thump in a small induced-draft fan engine. After trying about everything I ever knew or had heard of about causes of knocks in engines, but in vain, I finally found the trouble by having a man turn the engine over very slowly by hand. This disclosed that one of the lead weights, cast in the crank disk to balance the crank, was loose, and had just enough play in the disk to cause a knock at every revolution, especially when the engine started to speed up or slow down.

M. ERNST.

Stamford, Conn.

Restoring a Worn-Out Pump

A simplex steam pump, with a 6 x 12-in. water cylinder, had been used for pumping water containing a large amount of sand, and worked against a pressure of about 170 lb. The sand had worn the brass lining of the cylinder and the edges of the follower plate and flange of the piston until the pump became useless for the service required of it. It was then discarded and a centrifugal pump, with a device in the suction line for precipitating the sand from the water, was installed in its place.

Being in need of a feeder for a pair of boilers in the plant, the engineer decided to recover the old pump from the scrap pile and fix it up for this service. The water cylinder was fitted with a new brass liner, 6 in. inside diameter, and the edges of the follower and piston flange were made circular. It was then found that the piston and follower were nearly half an inch smaller in diameter than the bore of the new liner.

To restore the follower and piston-flange to their original diameter, the engineer first turned a dovetail groove, $\frac{3}{4}$-in. wide at the bottom, $\frac{1}{2}$ in. wide at the top, and $\frac{1}{2}$ in. deep, in the edge of each, as indicated in Fig. 1. He also drilled a number of small vent holes into each groove. He next made a form by sawing a round hole, a little more than 6 in. in diameter, in a hardwood board, and screwing this board to another one, as shown in Fig. 2.

He next heated the follower somewhat, laid it centrally in the form and poured a good quality of babbitt metal in the annular space around the edge. He did the same thing with the piston. But he had to make a new form for this part of the job, because he found it necessary to split the other one in order to remove the follower with the ring of babbitt metal attached. All that was needed now was to turn the babbitt metal attachments down to a proper fit in the cylinder.

The piston rod also was badly worn on the water end. After the rod had been trued up in the lathe, it was much too small for the throat of the stuffing box. To remedy this, the engineer made a bushing out of soft babbitt metal and turned one end of it tapering to fit the tapered bottom of the stuffing box. He then sawed through one side of the bushing longitudinally, as indicated in Fig. 3, spread out the severed ends, and slipped the bushing over the rod. When the ends were brought together, the bushing was driven home, being just a snug fit in the bore of the stuffing box.

St. Louis, Mo. A. J. DIXON.

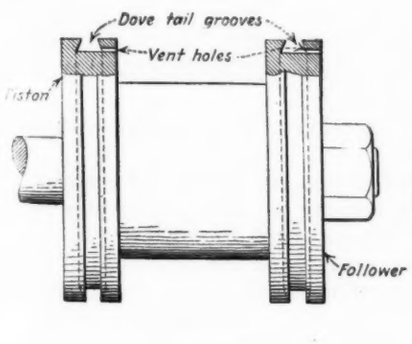


FIG. 1. GROOVED PISTON AND FOLLOWER

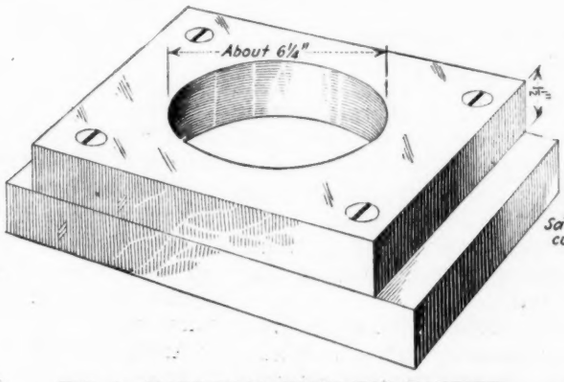


FIG. 2. HARDWOOD FORM FOR BABBITTING PISTON

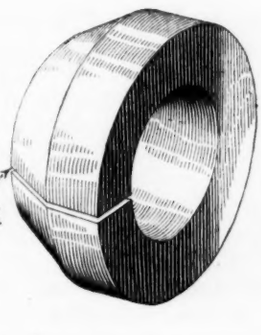
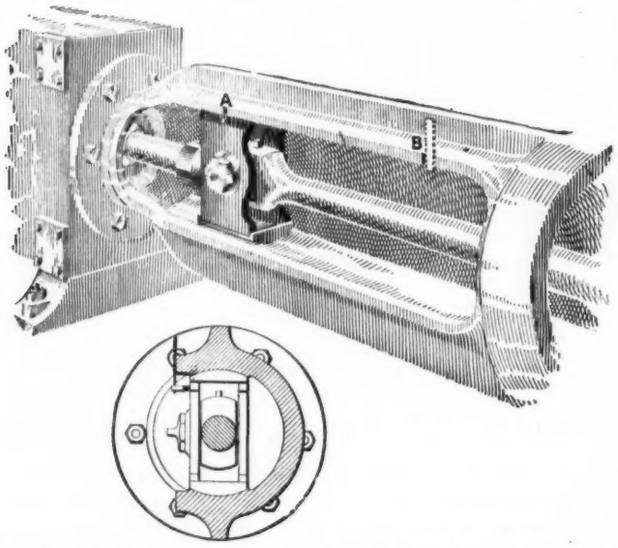


FIG. 3. BABBITT-METAL BUSHING

Checking Cylinder Clearance

The 18 x 42-in. engine in my charge has the usual clearance marks on the crosshead and at each end of the top guide to indicate how the piston clearance at the end of the stroke is divided. This engine makes 90 r.p.m., rendering it difficult to tell accurately where the clearance marks are traveling when the engine is up to speed.



SHOWS HOW CLEARANCE WAS CHECKED WITH THE AID OF SCREW AND SCALE

It was my desire to know just how these marks were registering under full speed, as well as when the engine was turning over slowly.

At the first opportunity I drilled and tapped a small hole about $\frac{7}{32}$ in. deep, and after cutting off the head and dressing two flat sides on a screw, I screwed it into the tapped hole with pliers. I then disconnected the engine and rearranged the marks on the top guide, for extreme travel each way, the mark *A* registering with the left-hand flat side of the screw and the mark *B* registering with the right-hand flat side of the screw. Care must be taken to see that the flat surface of the screw coincides with the line on the guides. With this arrangement, when the engine is up to speed, by placing a small metal strip or scale on the guide and advancing it slightly until the flat surface of the machine screw just touches it, and scribing a line on the guide, the clearance at the ends of the cylinder is plainly checked.

Allison, Ala. F. G. HEWLETT.

Voltage Fluctuated on Alternating-Current Generator

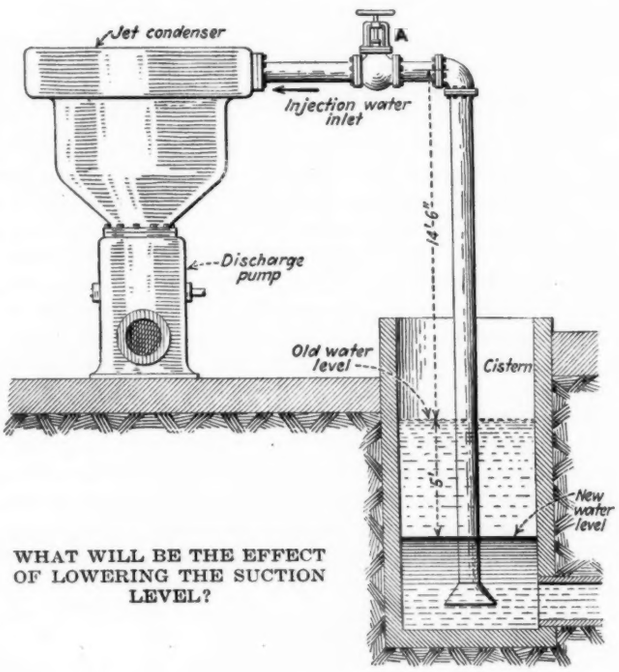
While on the midnight watch in an alternating-current generating plant I noticed that the voltage would drop from 1,100 to 700 or 800, when the load was practically constant. Whenever the voltage dropped, I would start to adjust it by regulating the field rheostat. A few minutes after leaving the switchboard the voltage would drop again, with the graphic wattmeter showing that the load was practically constant.

At first I thought that the speed of the engine was changing, therefore I put a tachometer on the generator shaft and found that the engine was running properly and the speed was steady. Later it was noticed that the exciter commutator was sparking, while the voltmeter indicated about 800 volts. Taking a piece of rag, I began to clean the exciter commutator and the voltage immediately came up to 1,100. The indications were that the trouble was due to sticking of the brushes and a dirty commutator. The commutator was being cleaned with the rag when the voltage suddenly dropped to zero and remained there, after which the engine was stopped and another machine put on the line. An examination showed that the brushes were tight in holders and the commutator dirty. After cleaning the commutator and fitting the brushes, the machine was again started and ran without further trouble. MEYER AXELROD.

New York City.

Effect of Suction Level of Jet Condenser on Pumping Cost

The accompanying figure shows a jet condenser and a water-pipe connection from the condenser into a cistern, from which the cooling water is drawn. The level of the water in this cistern will be permanently lowered five feet, owing to changes in our water supply. I have contended that this lowering of the level will not increase the cost of pumping. My theory is that the vacuum in the condenser is maintained for a purpose entirely independent of the lifting of the condensing water, that we must maintain the vacuum in any case for the purpose of condensing the steam, and



WHAT WILL BE THE EFFECT OF LOWERING THE SUCTION LEVEL?

that this vacuum has nothing to do primarily with the lifting of the water.

After we have secured the vacuum in the condenser for the purpose of condensing the steam, then the water is forced into the condenser by the atmospheric pressure on the surface of the water, and the lowering of this water level five feet will not increase the cost of pumping. FREDERICK L. RAY.

Anderson, Ind.

[*Power* readers are invited to discuss this question.—Editor.]

Why an Ejector Did and Did Not Work

It became necessary to empty a large cistern of warm water, and it was not convenient to move a pump and pipe it up to do the work. An ejector was made, as shown by Fig. 1, using a 1½-in. tee for the suction and discharge pipe connection, and the other end of the

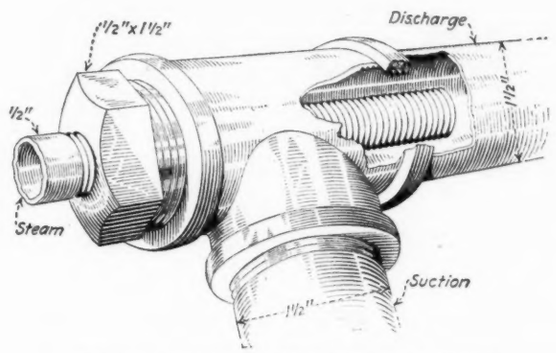


FIG. 1. THIS EJECTOR DID NOT WORK

tee reduced for a ½-in. steam pipe, which was threaded long enough to pass through the tee and just into the discharge pipe. This was placed on a level with the top of the cistern, the suction pipe being long enough to reach nearly to the bottom, a distance of 6 ft. Perhaps there was not sufficient steam used; at any rate the rig did not handle much water.

Then someone suggested that the ejector be placed just above the water level in the cistern, as shown by

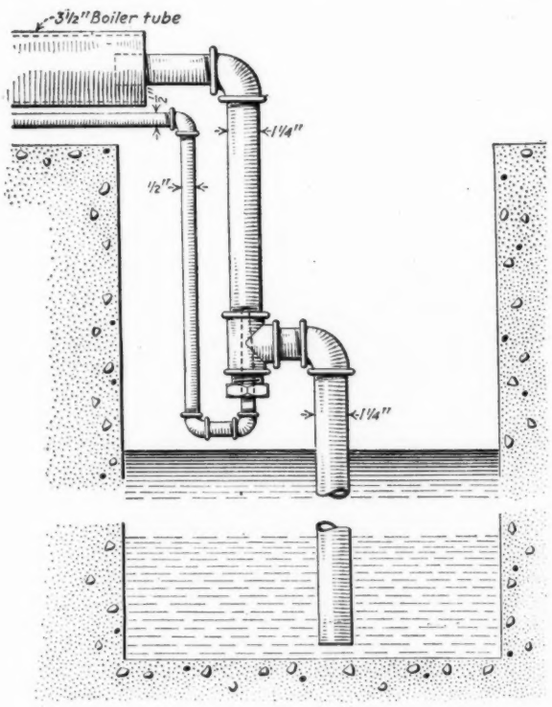


FIG. 2. HOW THE SECOND EJECTOR WAS PLACED

Fig. 2, and that a tapered steam nozzle be used instead of a straight one as in the first one that was tried. This was done, the ejector being placed at the bottom end of the discharge pipe.

In this instance a ½-in. steam pipe was used, but the suction and discharge pipes were made 1¼-in. in size. This did the trick.

Why the first arrangement did not work is probably because the vacuum formed in the ejector head was not sufficient to allow the warm water to rise sufficiently to reach the steam nozzle. O. R. NEW.

Atlanta, Ga.

Boiler Trouble with Fuel Oil

Are any readers of *Power* that are burning fuel oil under their boilers, troubled with unconsumed oil on the tubes, which gets very hard? I would like to know how to prevent this.

When I take a boiler off the line, the fires are cut down gradually for at least one-half hour before putting them out. I do this to save the brickwork from contracting too suddenly. At first I thought this was the cause of the trouble, but I have shut the burners off instantly when taking a boiler off, with the same results. Any advice on this subject will be appreciated.

Baltimore, Md. FRANK J. IMHOFF.

Small Chains as Trouble Savers

Years ago it was a common thing to see a teamster, laborer or fireman smoking what was called a T.D. pipe. Generally, a metal cap was fitted over the bowl, prob-

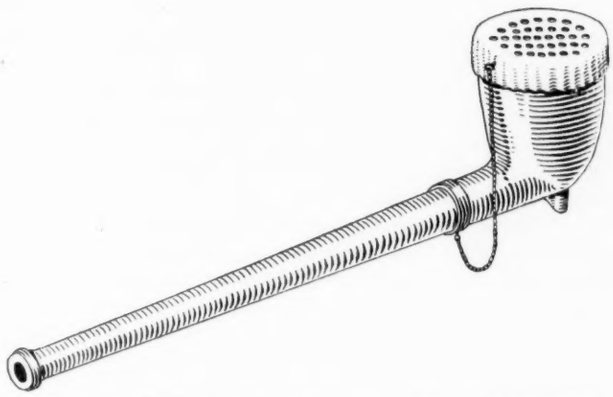


FIG. 1. POSSIBLY THIS WAS THE FIRST USE OF THE CHAIN

ably to keep the burning tobacco from flying about. This cap was secured to the pipe stem by a small chain and loose fitting ring, Fig. 1. This or similar applications of a chain have doubtless led to its adoption in a number of instances, and it may, if properly used, save an engineer more fruitless hunting than has ever been caused by the elusive collar button. There are a number of uses for a small chain in a steam plant, a few of which are shown in the accompanying illustrations.

How many times have you dropped the drain-cock plug of a lubricator because it was screwed out too far, or the filling plug while filling the lubricator? This little annoyance can be avoided by bending a piece of copper wire loosely around the stem of the filling plug, attaching the other end to the projection that supports the sight glass. The same idea can be applied to the shank of the drip plug, the other end of the chain being attached to the bottom connection of the gage glass. Thus when filling or if the drip plug is screwed out too far, the chain will suspend them ready for replacing

without instituting a personal search on the engine-room floor.

Some bearings are provided with a metal cover to fit in the opening that is provided in the top of the bearing. Grease is frequently used in such bearings, and the cover is naturally more or less greasy and may easily slide to the floor when placed on the bearing bedplate. By tapping a shallow hole in the bearing cup at any convenient place and screwing in a small eye screw, the bearing cover can be chained to it, as shown by Fig. 3, and there is then no chance of mislaying the cover plate. Another application of the chain is found in the case of recording instruments. Every engineer who has used such has at one time or another mislaid the round knobbed thumbnut or tension head that secures the paper chart to the recording disc. By putting a loose-fitting ring around the knob of the tension head and securing it to one end of a chain, the other end of the chain being fastened to the case of the instrument, all chance of dropping the tension head is done away with when changing charts (see Fig. 4). Several manufacturers of recording instruments now use a chain for this purpose as a part of the instrument which is a decided convenience when changing charts.

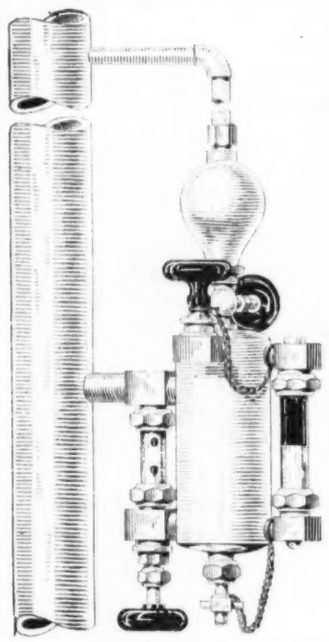


FIG. 2. CHAINS AS APPLIED TO A LUBRICATOR

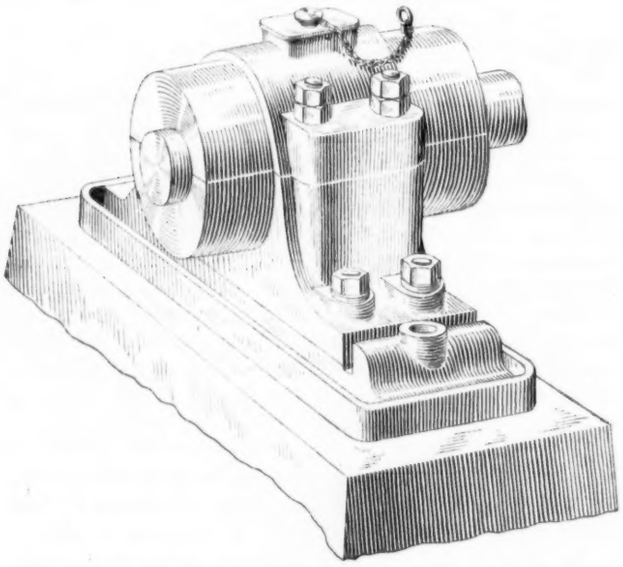


FIG. 3. THE BEARING COVER CANNOT BE MISLAID

In indicating an engine, it is not a good policy to leave the indicator attached to the indicator cock. When the indicator is removed, however, the cock should be protected by screwing on a cap. The question is: Where was the cap placed when the indicator was used? If the cap is secured to one end of a small chain, Fig. 5, the other end of which is attached to the indicator cock, there will be no question as to where it is when wanted.

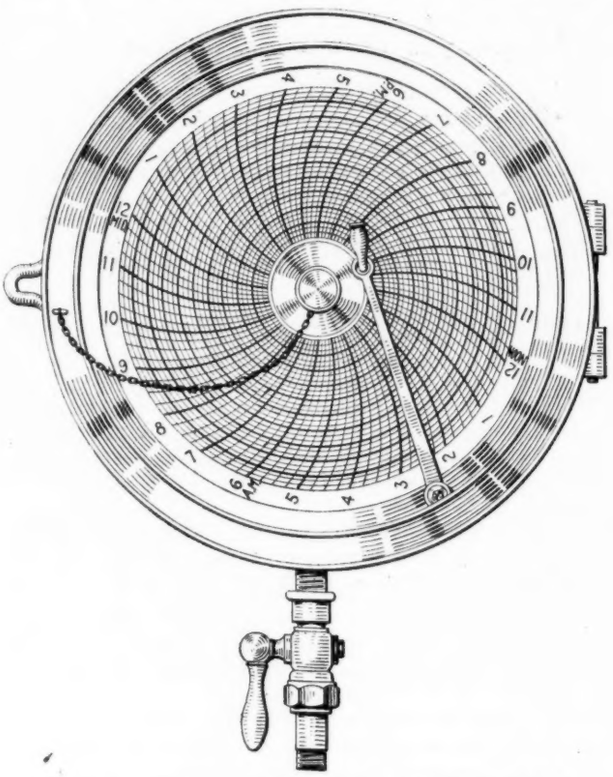


FIG. 4. CHAIN ATTACHED TO TENSION HEAD

Of course, in every instance where the chained object is to be screwed into place, the chain connection to it must provide for its turning freely. The several illustrations shown do not cover the many applications to which small chains may be put, but they are suggestive, and the reader will doubtless discover other uses for them in his own plant.

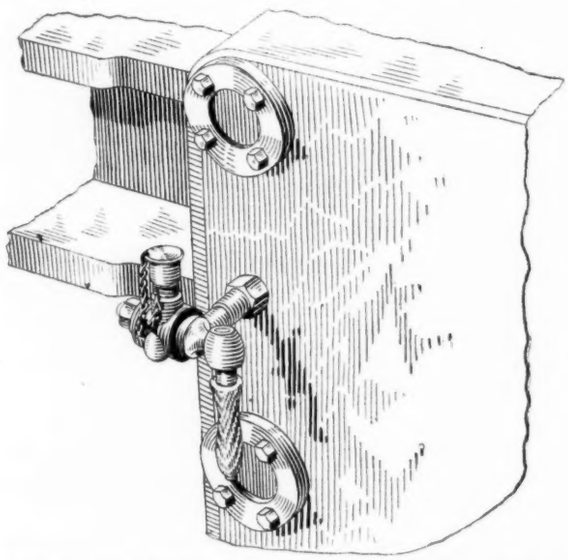


FIG. 5. THE COCK CAP IS ALWAYS WHERE WANTED

P. S. FRANKLIN.

Utica, N. Y.

COMMENTS FROM READERS

Compensating Pressure Gages for Error Due to Water Columns

Referring to John T. West's letter on page 195 of the Jan. 31 issue of *Power* on "Compensating Pressure Gages for Error Due to Water Columns," it should be noted that in order to obtain gage correction, head in feet of water should be divided by the constant 2.306, or multiplied by the constant 0.433, instead of being multiplied by the constant 2.306, as stated.

Newark, N. J. W. E. CLEMSON.

Water Power and Politics Tied Up in New York State

The article on "New York State Water Power Legislation," in *Power* for Jan. 31, brings to mind the fact that for many years the question of how the great water-power resources of the State of New York should be developed has been the subject of bitter debate at Albany. In general, the arguments have fallen naturally into two opposing propositions—the one of the state going directly into the business of supplying electricity to the people, and the other of the state producing electricity and selling it to the highest bidder who would take it away; the one seeking to commit the state to a policy of furnishing power to all who could use it as cheaply as possible, and the other attempting to protect vested interests in any electricity that is to be marketed, the result being that for years nothing at all has been done and tremendous water power in the state has gone to waste.

Ex-State Senator George F. Thompson, of Niagara county, now more or less out of politics, had a magnificent scheme for water-power development; all he lacked was the ways and means of raising $500,000,000 to put it into operation. Captain Clarke, who for years pestered the legislature with water-regulation and power-development propositions, had a plan all worked out to sell $300,000,000 worth of 100-year 2 per cent nontaxable bonds, and develop all navigable streams and water powers in the state. This was before the war, when his prices were probably accurate. Eventually, he went insane, and shortly afterward he died. Assemblyman Everett, of St. Lawrence County, perhaps the best-versed legislator on the practical side of water power, and interested from the standpoint of local pride in the development of the north country, says that the water power is here, the possibilities are unlimited, but the ultimate cost would be appalling. The whole situation is now in politics. If it can be taken out, there is a possibility that at some future date a substantial bond issue, such as $100,000,000, may be made.

Another interesting feature is that not a single sponsor of a power bill, and only one newspaper man in the Capital, has ever seen the locality of Crescent Dam and Vischer's Ferry, where is is proposed to make the initial experimental test of hydro-electrical development, although it is only 20 miles from Albany. Assemblyman Hackenburg has threatened to go up with a camera, an automobile and some newspaper men, and see for himself where he is spending $500,000 of the state's money. DON HOLBROOK.

Albany, N. Y.

Reforming Our Patent Laws

From the article in your issue of Jan. 24, I gather that the bill that has just passed Congress in relation to our patent laws merely proposes to increase salaries, personnel and fees, but it does not touch any vital point.

I am one among many who has had unpleasant experiences and who believes most of our present patent laws should be scrapped and new ones formulated that will discourage inventors of worthless things from applying for patents and at the same time protect inventions of commercial value.

As our patent laws stand at present, they encourage people who think they have discovered something new, to rush to the Patent Office with it and spend their hard-earned money for a "wortless scrap of paper," thus not only blocking the really important work of the department, but also wasting millions on patents that are of little or no value. It is said the Patent Office is over a year behind in its work because of the rush for patents and the inability to get competent examiners at the salaries paid under the present law. Is not this rush for patents due in a large measure to the very low fee exacted? And would it not be an improvement to charge a fee sufficiently high to discourage worthless inventions and inventors, and justify the Government in standing behind such patents as it does issue?

There is no more direct way for an inventor of merit to lose his grip on his invention than to have it patented under our present patent laws, unless he has the means to protect his rights in the courts, for under our present laws the inventor in his application must expose the most vital features of his invention; and this is just what patent thieves are constantly on the lookout for, as many of us know to our sorrow.

Confirming this statement, I may quote a no less authority than Dr. L. H. Baekeland, for many years chair-

man of the committee on patents of the American Institute of Chemical Engineers, who in a recent article on this subject says: "If the United States Patent Laws had been conceived for the special benefit of patent pirates, they could not be greatly improved upon." This same authority recently told the writer he had just recovered $3,500 for infringement of one of his patents, after some five years' litigation and an expenditure of about $15,000 on his part.

I might mention another case of an old engineer who, because of his expert skill in his profession, was often sought by such pioneers as Capt. John Ericsson, C. H. Delamater, Henry R. Worthington, Sr., William Wright, George H. Corliss, etc., who some few years since brought out under American patent an article of considerable commercial value, which was promptly "appropriated" by a concern in Chicago, among others. Suit was brought. The pirates attorney's chief argument was, first, "they had $1,000 to the inventors $100. Then again the inventor was an old man and could not be expected to live much longer, and even if he did win in the lower courts, the pirates would carry it up until the inventor died and was out of the way."

But the old engineer having laid aside something for possible old age, fought the case through the courts for seven years, when his bank account gave out and he was forced to quit, but is still living, and is now in his old age and has to depend on the kindness of his friends, and what little he can earn, for his maintenance, while those who secured his patent are deriving a good revenue from his invention. Does not a law that permits this, need reforming? W. H. ODELL.

Brooklyn, N. Y.

Mechanical Analogy of an Evaporator

There are many ways of explaining how a piece of apparatus works. One method is to describe what actually happens; another is to compare the action of the apparatus that is being described with the operation of some easily understood mechanism. The first method is exemplified by the article on evaporators in the Feb. 21 issue of *Power*. Readers who have followed the explanation in that article may be interested in a mechanical analogy of the double-effect evaporator which is herewith presented.

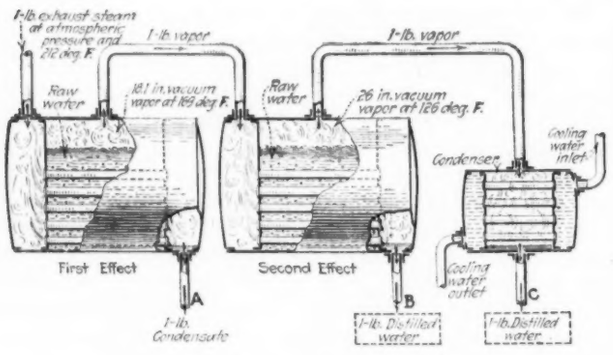


FIG. 1. DIAGRAM OF DOUBLE-EFFECT EVAPORATOR

Fig. 1 shows the diagram of the double-effect evaporator and condenser, as given in the evaporator article, while Fig. 2 shows its mechanical analogy. Unfortunately, the latter looks suspiciously like a perpetual-motion machine, but that cannot be helped. Moreover, it is true that, if laid out exactly as illustrated, it could not work on account of friction. On the other hand, it will be recalled that the evaporator pictured was also an ideal case, in that an actual double-effect evaporator could not produce two pounds of distilled makeup water per pound of exhaust steam, but something less. If the reader will kindly neglect the friction losses for the moment, this point can be fixed up for him a little later.

It will be noted that the two effects and the condenser are each represented by a pair of pulleys (one above the other) connected by a belt with projecting supports, by means of which weights can be raised or lowered. The weights used are round steel balls weighing one pound each. When a ball is at the upper level, it has much potential energy and represents a pound of steam, but when it is at the lower level it has little potential energy and represents a pound of water. No attempt has been made to parallel the fine points, such as the difference in energy between steam at one pressure and that at another. The only distinction, so far as energy is concerned, is between steam (vapor) and water.

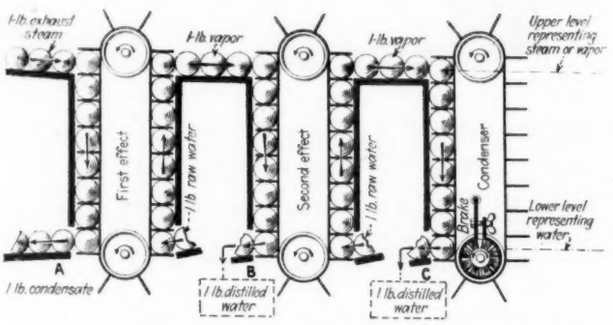


FIG. 2. MECHANICAL ANALOGY OF DOUBLE-EFFECT EVAPORATOR

Neglecting friction and referring to the diagram, it is seen that one pound of "exhaust steam" enters the first effect and falls to the "low" condition of "condensate." It thereby raises one pound of raw water to the "high" condition of one pound of vapor. This pound of vapor passes into the second effect, where it falls to the low condition of one pound of distilled water, and in the process raises another pound of raw water to the high condition corresponding to one pound of the vapor.

This second pound of vapor is carried to the condenser, where it is lowered to the condition of one pound of distilled water. The energy of the vapor coming to the actual condenser merely heats the cooling water, and does not produce any more vapor. Therefore, in the "condenser" of the analogy a brake takes the place of the rising weights.

It will be seen that Fig. 2 is a rather close analogy of Fig. 1. In actual practice the distilled water coming off at *B* and *C* in Fig. 1 might have to be reduced to, say, 0.9 lb. and 0.8 lb. respectively. In the same way it is reasonable to suppose that if an apparatus like Fig. 2 were to be actually constructed it would be necessary to use balls weighing 0.9 lb. between the first and second "effects," and 0.8 lb. between the second "effect" and "condenser," if the apparatus were to be self-operating. R. N. HARRISON.

Cleveland, Ohio.

Cold-Working of Drum Head Dangerous

I notice in your issue of Feb. 7 the article by G. W. Atkinson on damage to a drum head that might have resulted in a boiler explosion. It would seem clear from the evidence presented, that the damage was initiated by cold work due to the hammering near the radius of the head.

It does not seem to be yet realized that steel of the composition and tensile strength that this material had, cannot be hammered or otherwise cold-worked safely. The Boiler Code Specifications, which are the same as the A. S. T. M., provide no carbon limit for flange steel, while the upper limit for tensile strength is 65,000 lb. Steel of this character will not stand "hammer dressing," and a number of serious accidents are on record as having occurred from this practice. Soft low-carbon material will stand such treatment much better than flange steel, especially if the latter be not of good general quality.

It would be interesting to know more about this case, particularly as to why the hammering was done, if it is possible to find this out. The fact remains, however, that hammering steel of this character is dangerous, regardless of the reason for it.

Rochester, N. Y. S. W. MILLER.

Should Oil-Field Boilers be Exempt?

One of your readers has raised some rather interesting points in connection with the writer's recent article covering a fatal boiler explosion in the California oil fields. Without desiring to enter into a controversy, it is felt that a reply is warranted in this case because your correspondent is evidently unfamiliar with the conditions under which boilers are operated in the California oil fields.

First, it should be noted that the inspector, who examined the exploded boiler two months prior to the explosion, made a regular "internal inspection," at which time the boiler was open. Therefore, he could not determine the pressure at which the safety valve was set to blow. It is the practice of insurance companies to make one internal and two or three external inspections annually, so that the regular external inspection was not due for about two months. The inspector states positively that he was not informed by the fireman that the safety valve was inoperative. Consequently, the only blame attachable to him was failure to report the absence of any lifting device by which to test the valve. Even this point is doubtful, as there is evidence to show that the safety valve was changed, but whether just before or just after the inspection is not quite clear.

The changing of safety valves in the oil fields is a frequent occurrence, as it is well known that the water is of such a nature as to cause the valve to stick to its seat in periods varying from a few weeks to even a few days. As a result it is entirely possible that the valve was free at the time of the inspection and became stuck afterward, being changed for another valve which in turn became stuck. Hence, under those circumstances, even with a reasonable doubt existing, it would have been unjust to censure the inspector.

Secondly, in regard to the defective pressure gage. Ordinarily, only the cheap class of gage is used, because the boilers are set up in the open or at best in a mere shack (except in the plants operated by the large corporations) in line with the more or less temporary nature of the installation. That is, when drilling for oil, a temporary installation is used, which only too frequently becomes more or less permanent after oil has been struck.

A better understanding of the operating difficulties may be gained when it is understood that boilers themselves are commonly changed every two weeks by drawing them bodily from the setting and sending them to the "racks," where the tubes have to be taken out in order that the boiler may be scaled.

Had the operating conditions, under which this boiler exploded, been anywhere near normal, or if it were possible reasonably to assume that even appliances on an installation would remain unchanged from internal to external inspection, it might be possible to attach some responsibility to the inspector. As things are, however, the responsibility must rest on the people of the state for failure to enact and enforce laws which will require a man to have some comprehension of the forces in boilers before permitting him to operate them.

San Francisco, Cal. R. L. HEMINGWAY.

Belt Slipping Caused Flickering of Lights

According to the readers of *Power*, the "Flickering of Lights" is caused by a number of varying conditions. In the plant in which I am employed, there is a plating dynamo that is belt-driven by an alternating-current motor supplied with power from a near-by transmission line. We also utilized the direct current from this generator to light the plating department. These lights were connected through a double-throw switch having alternating current on one side as an emergency supply. After putting the generator in operation with the lighting switch closed on the direct-current side, the lights were satisfactory for five or six months.

One day the lights began to flicker slightly and gradually grew worse. I looked over the belt and it appeared in good condition, having a fair tension. The commutator and brushes were inspected, as well as the rheostat and nothing was detected. A speed test on the generator was made, and although it was found about 100 r.p.m. slower than the rated speed, it was not considered that this would necessarily cause the lights to flicker uniformly, as they did. After the belt on the generator pulley had been watched closely, it was noticed that there was a slight sudden shifting toward the inside of the pulley. I took a stick and held it against the side of the belt to hold it steady, and found that the lights gradually ceased to flicker. When the stick was released from the belt, the flickering began again. It was found that a crook had formed in the cemented splice and caused the belt to jump off the crown of the generator pulley. This was enough to produce a slip every time the defect passed, therefore varying the speed and generator voltage, which consequently affected the lights. While we may not find such trouble as this in large belt-driven generators, this experience would show that it is not impossible. JOSEPH F. BERNARD.

Aurora, Ill.

The capacities of passenger elevators vary from about 1,000 lb. in residences to 5,000 lb. in department stores, and from 2,000 to 3,000 lb. in office buildings. The capacity determines the car size, which should be of sufficient floor area to provide not over 75 lb. per sq.ft., which is an accepted standard throughout the United States.

QUESTIONS AND ANSWERS

Relative Value of Acetylene Gas

What is the heating value of acetylene gas, and how does this gas compare with gasoline as a fuel for internal-combustion engines? L. G. N.

Acetylene gas has a heat value of 21,000 B.t.u. per pound, and a pound occupies a volume of 14 cu.ft. at 62 deg. F. The market price of acetylene is around 3 cents per cubic foot, or 42 cents per pound. Gasoline has a heat value of approximately 20,000 B.t.u. per pound, and if it has a gravity of 58 Baumé there will be 6.2 lb. in a gallon. At 30 cents per gallon a pound costs approximately 5 cents. The comparison on a basis of cost becomes gasoline to acetylene is as 5 × 20,000 is to 42 × 21,000, or as 1 to 8.82; that is, for the same speed can be obtained.

Size for Governor Driving Pulley

How may it be known what size of pulley should be placed on the shaft of an engine for driving a throttling governor? C. N. R.

There is a certain speed of revolution at which any governor works best, and the manufacturers usually stamp figures on the governor that indicate the r.p.m. recommended for the receiving pulley furnished with the governor. Knowing the r.p.m. desired for the engine, the diameter of governor driving pulley that is to go on the engine shaft is found by multiplying the diameter of the governor receiving pulley by the r.p.m. for the governor and dividing the product by the r.p.m. desired for the engine. Most throttling governors are provided with a spring or a weight adjustment, for assisting or retarding the centrifugal action of the balls, by means of which a considerable modification of engine speed can be obtained without changing the sizes of pulleys.

Vacuum Reading Reduced to Standard 30-Inch Barometer

If the actual height of mercury in a vacuum gage is 26.5 in., temperature of mercury 80 deg. F., barometer (at the time and place) 29.85 in. at 42 deg. F., what is the equivalent vacuum referred to standard 30-in. barometer? J. C. C.

The standard atmospheric pressure at average sea level is the pressure corresponding to that of a mercury column 29.92 in. at 32 deg. F. To refer the readings of the vacuum gage to a 30-in. barometer and standard atmospheric pressure, it is necessary to increase the standard temperature of 32 deg. F. to such a figure as would increase the height of the mean barometer from 29.92 to 30 in. Taking the coefficient of expansion of mercury to be 0.000101 per deg. F., the increase of temperature required would be (30 — 29.92) ÷ 29.92 × 0.000101) = 26.4 deg. F., so that the temperature of a 30-in. mercury column that would exert the standard atmospheric pressure would be 32 + 26.4 = 58.4 deg. F.

The mercury column correction for any change in temperature may be approximated by the formula,

$$h = h_1 [1 - 0.000101 (t_1 - t)]$$

in which h = height of mercury column corrected to temperature t; h_1 = observed height of mercury column; t_1 = observed temperature of mercury column; and t = temperature to which column is to be referred.

The stated vacuum gage reading of 26.5 in. at the temperature of 80 deg. F., reduced to 58.4 deg. F., would be

$$h = 29.85 [1 - 0.000101 (80 - 58.4)] = 26.44 \text{ in.}$$

and the barometer reading of 29.85 in. at 42 deg. F. reduced to 58.4 deg. F. would be

$$h = 29.85 [1 - 0.000101 (42 - 58.4)] = 29.9$$

Hence the absolute pressure in inches of mercury at the temperature 58.4 deg. F. would be 29.9 — 26.44 = 3.46 in. mercury, and the vacuum referred to standard atmospheric pressure reduced to 30-in. barometer would be 30 — 3.46 = 26.54 in.

Heating of Two-Phase Induction Motor When Operated Single-Phase

After testing a 2-hp., 2-phase 220-volt 60-cycle motor at full rated voltage and finding it in good condition, experiments were tried on 110 volts single-phase, which resulted in excessive heating of the stator core and also peculiar speed conditions. The temperature of the iron would rise in a very short time while the windings were yet cold. The rotor had a squirrel-cage winding which heated very little. A four-pole switch was connected in the circuit in such a way that when the switch was thrown up the motor was started on 110-volt two-phase and would run up to near synchronous speed. When the switch was thrown down, the windings were connected in series and across one 110-volt phase. The machine would then operate single-phase and the speed would drop slightly. By applying a brake—which was only a pad in the hand—the speed was reduced to 800; then to 400 and then to 100 r.p.m., which would remain stable after the removal of the brake. With the switch down the motor could be started from rest by hand, but could not be made to run over 100 r.p.m. As was to be expected the current and torque were small, but the stator iron heated in the manner already stated. Why was this so? H. M.

The test on the motor indicated abnormal temperature rise and unstable speed. No mention is made of the actual temperature observed according to a thermometer. With a temperature rise of 40 deg. C., which is allowable for such apparatus, it might appear to almost

any one that the temperature was excessive in magnitude. Of course, if the windings smoked during the test, then there would be no question that something was wrong, even if a thermometer were not available for determining the actual temperature. The windings, being covered with insulation, would not feel as hot as the iron even though they were of the same temperature.

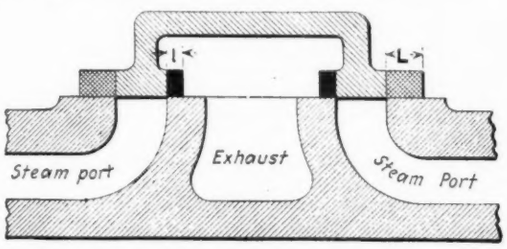
The windings, which had a normal rating of 220 volts, when connected in series on 110 volts would give a very small torque owing to the weak magnet field. In the test the torque was apparently just sufficient to overcome the friction, so that almost any speed could be obtained as long as the motor was running with no load.

Two-phase motors, when brought up to speed will continue to operate satisfactorily as single-phase motors if one phase is opened, keeping in mind that the capacity is, of course, correspondingly reduced. There are on the market single-phase motors that have two windings, one a high-resistance auxiliary starting winding. When starting up, the condition is similar to a two-phase motor, but when normal speed is reached the auxiliary winding is cut out from the circuit, the motor running then as a straight single-phase motor. In general, induction motors are designed to operate on 10 per cent variation in voltage or frequency from normal. If these limits are exceeded, the machine should not be held responsible if it operates unsatisfactorily. Whenever an induction motor is connected under such radical conditions as outlined in the question, almost anything might be expected to happen.

Outside and Inside Laps of D Slide Valve

What is meant by outside and inside lap of a D slide valve? M. C. R.

When the valve is placed in its central position with reference to the ports, the distance which it overlaps the steam ports is called the lap of the valve.



The length of the double shaded part L, shown in the figure, is called outside lap, and sometimes is designated steam lap, because it is the amount of overlapping of that portion of the valve which controls admission of steam to the port. The length of the black piece l is called inside lap, and sometimes is designated exhaust lap, because it is the overlapping by that part which controls the escape of steam from the steam port to the exhaust.

Duty of Duplex Pump

What is the duty of a duplex pump that delivers 2,890,000 gal. of water in 12 hours, with a suction lift of 12 ft. and pumped against a pressure of 30 lb. per sq.in., with a coal consumption of 24,470 lb.?

L. A. H.

On account of the wide difference in the evaporation efficiency of various fuels, the old unit of duty of foot-pounds of work per 100 lb. of coal used has, for many years, been superseded by the unit, foot-pounds of work per million heat units furnished by the boiler; 2,890,000 gal. of water raised 12 ft. by suction lift, and pumped against a pressure of 30 lb. per sq.in., would amount to development of

$$[2{,}890{,}000 \times 8.3356] \times [12 + (30 \times 2.309)] = 1{,}957{,}784{,}873 \text{ ft.-lb.}$$

By the old unit, the duty would be

$$1{,}957{,}784{,}873 \div (24{,}470 \div 100) = 8{,}000{,}755 \text{ ft.-lb. per 100 lb. of coal.}$$

To obtain the same duty per million heat units furnished by the boiler, each pound of coal would have to impart 10,000 heat units to the water in the boiler, and the evaporation would need to be $10{,}000 \div 970.4 = 10.305$ lb. of water from and at 212 deg. F. per pound of the coal.

Discharge of Steam Through Apertures

What quantity of steam at the initial pressure of 75 lb. gage would be discharged per minute through apertures respectively $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$ and $\frac{3}{4}$ in. in diameter with discharge taking place into a condenser where there is 26 in. vacuum? R. P.

Having an initial pressure of 75 lb. gage, or $75 + 14.7 = 89.7$ lb. per sq.in. absolute, and the final pressure of 26 in. vacuum, or $(30 - 26) \times 0.491 = 1.96$ lb. per sq.in. absolute, the final pressure would be less than 58 per cent of the initial pressure, and Napier's approximate rule would apply; namely,

Flow in pounds per sec. = absolute initial pressure × area of aperture in square inches ÷ 70.

Hence per square inch of aperture the flow would be $89.7 \times 1 \div 70 \times 60 = 76.88$ lb. per min.

As the area of $\frac{1}{4}$ in. dia. = 0.04909 sq.in., $\frac{3}{8}$ in. dia. = 0.11045 sq.in., $\frac{1}{2}$ in. dia. = 0.19635 sq.in., and $\frac{3}{4}$ in. dia. = 0.44179 sq.in., the discharge would be:

$76.88 \times 0.04909 = 3.77$ lb. per min. for $\frac{1}{4}$-in. aperture;
$76.88 \times 0.11045 = 8.49$ lb. per min. for $\frac{3}{8}$-in. aperture;
$76.88 \times 0.19635 = 15.09$ lb. per min. for $\frac{1}{2}$-in. aperture;
$76.88 \times 0.44179 = 33.96$ lb. per min. for $\frac{3}{4}$-in. aperture.

Required Diameter of Engine Cylinder

What diameter of engine cylinder would be required to develop 59.5 i.hp., having 15-in. stroke, 250 r.p.m. and 38 lb. m.e.p.? C. L.

The usual formula for power developed by an engine is

$$i.hp. = \frac{P \times L \times A \times N}{33{,}000},$$

in which P = m.e.p., L = length of stroke in feet, A = area of piston in square inch; and N = number of single strokes per minute. Multiplying both sides of the equation by 33,000 and dividing by $P \times L \times N$ gives $A = \frac{33{,}000 \times \text{i.hp.}}{P \times L \times N}$; substituting the values given in the question would make

$$A = \frac{33{,}000 \times 59.5}{38 \times \frac{15}{12} \times 250 \times 2} = \frac{1963500}{23750} = 82.6736 \text{ sq.in.}$$

Hence the required diameter would be

$$\sqrt{\frac{82.6736}{0.7854}} = \sqrt{105.26} = 10.25 \text{ in.}$$

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Power Generation and Distribution Discussed

CENTRAL-STATION power generation and distribution from the operator's viewpoint was the subject discussed at a joint meeting of the New York Section of the American Institute of Electrical Engineers and the Metropolitan Section of the American Society of Mechanical Engineers, in the Auditorium of the Engineering Societies Building, New York City, Friday evening, Feb. 24. The subject was comprehensively covered in the four papers presented: "Report Upon Efficiency Tests of a 60,000-Kw. Cross-Compound Triple-Cylinder Steam Turbine," by H. B. Reynolds and W. F. Hovey, of the Interborough Rapid Transit Co.; "Present Day Boiler-Room Operation," by I. E. Moultrop, of the Boston Edison Illuminating Co.; "Electric Drive for Steam Generating Station Auxiliaries," by H. C. Albrecht, Philadelphia Electric Co.; and "Three-Phase, Four-Wire Distribution System," by Thomas Sproule, Public Service Electric Company of New Jersey.

A comprehensive abstract of the paper, "Report on Tests of the 60,000-Kw. Turbine," will appear in Mar. 14 issue of *Power*. Beginning on page 384 of this issue is an abstract of Mr. Moultrop's paper on "Present-Day Boiler-Room Operation."

H. C. Albrecht in his paper "Electric Drive for Steam Generating Station Auxiliaries,"[1] said in part:

Electric Drive for Station Auxiliaries

In the last few years the use of electric drive for generating station auxiliaries in preference to steam drive has increased tremendously, particularly in large modern plants. This change in practice has been brought about largely by the following factors:

1. The increased auxiliary power demands per kilowatt of generating capacity in modern stations to obtain greater plant economies.
2. The wider latitude in the selection of methods for obtaining heat balance under all conditions of varying load and seasons, and the ease of its adjustment.
3. The high maintenance costs of speed-reduction gearing generally used with steam-driven equipment.
4. The high condensation losses and complications of auxiliary steam piping.
5. The further application of alternating current to auxiliary drive, particularly at 2,300 volts.

When decision to use a considerable proportion of electric drive for auxiliaries has been made, it becomes necessary to decide upon the method of energy supply and distribution. Energy may in general be supplied from (a) the main generating units or main bus, (b) house turbo-generators, (c) a combination of supply from main units or main bus and house turbo-generators.

Some of the advantages of supply from the main generating units or main bus through transformers are low investment costs, small space requirements and simplicity of operation as compared to supply from house turbo-generators. There is also possible with this method great flexibility in obtaining heat balance by bleeding of the main units, by use of steam drive or dual (steam electric) drive for some of the large auxiliaries or by combinations of these plans.

The house turbo-generator method of supply has the advantage of complete isolation from the main generating system and of lessened duty on equipment during system disturbances, with consequent greater reliability of service, although in addition to being more costly and requiring more space than the transformer method, it gives much less flexibility in obtaining heat balance.

A combination of supply from the main units or main bus and of house turbo-generators has the merits of both methods and also gives the additional distinct advantage of two independent sources of supply. Great flexibility can be obtained in the adjustment for heat balance, but more space and greater investment are required than when supply is obtained through transformers from the main units or main bus.

[1] Also see article "Driving Power-House Auxiliaries," page 166, *Power*, Jan. 31.

The outstanding feature of the increased use of electrically driven auxiliaries has been the extensive application of the alternating-current motor and particularly the use of 2,300-volt motors in sizes of 50 hp. and above.

The distribution of either alternating current or direct current at voltages of 600 and below for the auxiliaries in a large plant involves very great investment and heavy losses and is decidedly uneconomical when compared with distribution when a considerable portion of the load consists of 2,300-volt motors driving the larger auxiliaries. In most of the stations of large capacity built within the last few years 2,300-volt motors are being used quite extensively and with entire satisfaction. In the selection of such motors and their control equipment, however, it is important to be assured of sturdiness of construction, ample clearances and simplicity of operation. An indication of the general trend which is of particular interest is that in the Hell Gate Station recently placed in operation, (a) all auxiliaries, with the exception of two or three steam reserves, such as emergency boiler-feed pumps, etc., are electrically driven; (b) all the auxiliary motors are alternating current; (c) all motors above 25 hp. are 2,300 volts.

In the application of the alternating-current motor to auxiliary drive one of the chief problems has been the development of satisfactory equipment for adjustable-speed service. The direct-current motor until recent years has been used to a great extent for this service principally because of its very satisfactory inherent characteristics for such application. The development of the alternating-current motor to satisfactorily replace the direct-current motor for adjustable-speed service has presented many difficulties and has so far included the following types of equipment: (a) The constant-speed motor with some form of mechanical speed-changing device or the multi-speed pole-changing motor with or without mechanical speed-changing device; (b) the wound-rotor type of motor with external resistance; (c) the brush-shifting commutator type motor.

In considering the extensive use of electric drive it is necessary that the selection and layout of the equipment should be such as to give a high degree of reliability, because of the importance of the service. In case of trouble defective equipment must be immediately isolated with a minimum effect on other apparatus.

The type of auxiliary drive has such an important bearing on the method of securing heat balance and consequently upon station economy and upon simplicity and ease of operation, that there should be complete co-operation between mechanical and electrical design and operating engineers in its selection.

It is gratifying to record that much of the recent progress in the application of electric drive is directly due to such co-operation and undoubtedly the next few years will bring further developments.

Mr. Sproule's Paper

In his paper, "Three-Phase Four-Wire Distribution Systems," Thomas Sproule discussed the advantages of changing from a 2,300-volt two-phase four-wire system to a 4,000-volt three-phase four-wire system. Where standard 2,300-volt transformers are used, they can be connected in star to obtain the 4,000 volts, with the fourth wire brought from the star neutral. Such a system gives 4,000 volts between the three phase wires and 2,300 volts from each phase wire to neutral, from which any single-phase 2,300-volt load may be taken just as from the usual 2,300-volt system. The 4,000-volt system, Mr. Sproule points out, has the advantage of a higher efficiency, greater area of power distribution, better regulation, substations can be utilized more efficiently, the line losses are less, and a 50 per cent increased capacity of the system can be obtained at a cost below that of any other method. The speaker told of one large system that had changed over from 2,300-volt, four-wire two-phase to 4,000-volt, four-wire three-phase, and as a result the line losses had been reduced 2,000,000 kw.-hr. per year.

In the discussion Francis Hodgkinson pointed out that there are many other factors in power-plant economy besides the main units, and the bolier plant is one of the most important of these. He said that it was regrettable that there were not more tests made on large turbines, and that it was highly commendable on the part of the Interborough Rapid Transit Co. to forego the expense, time and effort to make these tests. Auxiliary drive is influenced by many factors in power-plant design, said the speaker. A few years ago every power plant installed steam-driven auxiliaries because they were more reliable, but that is not a factor today. One of the reasons for using electrically driven auxiliaries is to get away from the dirt, wet and grease, attendant to steam equipment.

Dr. D. S. Jacobus told of the old way of operating power plants and illustrated his point by a story of a case where an exhibition test was being conducted on a steam-electric plant to show that electric power could compete with gas. Under no condition was the plant to be allowed to fail. After getting nicely started, a gasket blew out in the feed-water line and before this could be repaired the water dropped out of sight in the boiler, after which the engineer got a piece of chalk and every two or three minutes would mark on the boiler where he thought the water was. After the feed-water pipe was repaired the engineer ordered everyone to get out while the getting was good before he turned water into the boiler, but nothing happened.

During the discussion some objections were raised against the four-wire 4,000-volt three-phase system on account of the increased hazard to employees getting shocked from this voltage. Philip Torchio took exception to this objection by pointing out that in this country power is distributed over insulated wire, where abroad bare wire is used, with entire satisfaction and safety to life. The speaker felt that if we look at the 4,000-volt distribution system in this light we need not have any apprehension about increasing distribution voltages from 2,300 to 4,000. If employees will not pay attention to instructions for their safety, they will get killed as quickly on 500 volts as 4,000. Mr. Torchio was of the opinion that if we can safely operate at 2,300, then we can at 4,000 volts, and no criticism should be leveled at the four-wire three-phase system on that score. The speaker said that alternating-current distribution was just in its infancy and that as the systems increased in size, the four-wire three-phase system would become a necessity in solving the distribution problem as it offers a means of transmitting 70 per cent more power with the same copper, or a means of having 30 to 40 per cent less overhead wires.

Hark Back to Achievements of DeLamater and Ericsson

March 9, the sixtieth anniversary of the battle between the "Monitor" and the "Merrimac." will be marked by the unveiling of four bronze tablets in honor of the two men

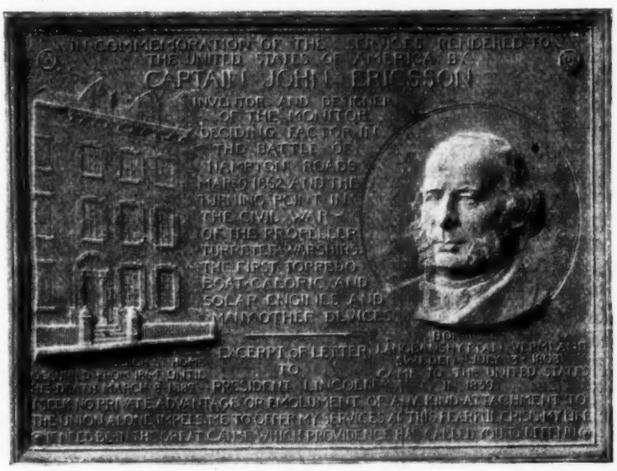


FIG. 1. THE TABLET THAT WILL MARK CAPTAIN ERICSSON'S HOME

FIG. 2. THE TABLET FOR THE SITE OF THE OLD PHOENIX FOUNDRY

who built the plucky little vessel that won one of the most famous naval battles of history. The affair is being arranged by the DeLamater-Ericsson Commemoration Committee, composed of representatives of various engineering and other organizations.

The tablet shown in Fig. 1 is to be set up at Captain Ericsson's old home at 36 Beach St., New York City, and will be unveiled by representatives of the American Society of Swedish Engineers. The one shown in Fig. 2 will be placed upon the site of the Phoenix Foundry, where much of Captain Ericsson's early work was done, by the General Society of Mechanics and Trademen.

Of the two other tablets, not shown here, one will be unveiled by the Associated Veterans of the DeLamater Iron Works at Cunard Pier No. 54, at the foot of West 30th St., New York City, the site of the old DeLamater iron works; the other will be unveiled at the Continental Iron Works, West Calyer St., Brooklyn, New York, by Thomas F. Rowland (the president of the works) and his staff. The four events will take place March 9 at 2, 3, 4 and 3 p.m., respectively.

The tablet on the Cunard pier will be accepted by Mayor Hylan for New York City, while the others will be accepted by Dr. George F. Kunz for the American Scenic and Historic Preservation Society. The United States Navy Department will also be represented.

In the evening there will be a banquet at the Waldorf-Astoria, which will be attended by representatives of the United States and the Swedish Government, of various historic, civic and technical organizations, and of ordnance, shipbuilding and shipping interests. A few seats will also be available to the general public (ladies included) tickets being obtainable at the Engineering Societies Building, 29 West 39th St., New York City. Those present will be in communication by cable with a simultaneous banquet in Stockholm, Sweden, which will be attended by members of the Royal family and the American Minister and Consul.

At the National Motor Boat Show, which was held recently in New York City, an individual who remarked several times that he knew "a thing or two about engines," tried to persuade the man in charge of the Sperry compound Diesel engine exhibit that spark plugs would make his Diesel engine much more reliable. He said that he was in the business and that he would be glad to deliver spark plugs that would make the Diesel engine really reliable, instead of just an impractical experiment. The attendant's tactfulness was exemplary, but of course he had to be a man of great patience to explain the principles of the compound Diesel engine to the general public.

Sweden now has an interconnected electric power system extending from Norrland in the extreme north to Skane in the south. Advices to the Department of Commerce tell of the completion of the last link in the system, which covers the 196 miles between Trollhattan and Vastera. The line will carry 220,000 volts.

Congress Comparing Muscle Shoals Offers

While there has been a noticeable tempering of the opposition that was so pronounced during the early hearings before the Military Affairs Committee of the House of Representatives on the Muscle Shoals offers, there is no certainty that the committee will recommend the acceptance of Mr. Ford's offer. While the offer of the Alabama Power Co. is very generally admitted to be in more business-like form and to be surrounded by fewer uncertainties, it has met with a particularly hostile reception in Tennessee and Alabama, which feeling is reflected by the Senators and Representatives from those states.

The other offers are not considered important. The Construction Company of North America is understood to have definitely retired from the bidding. The Engstrum offer has been transmitted to Congress, but it is apparent that it cannot be considered a real competitor of the offers made by Mr. Ford and by the Alabama Power Company.

The Engstrum proposal subordinates all other considerations to nitrogen production, financing that by the sale of surplus power. It calls for the lease of the entire property involved, including the Warrior plant, for a term of fifty years; for completion of the Wilson Dam, power plant and other structures already begun or agreed upon; for the construction of locks; and for the manufacture of nitrates. The construction work would be handled on a cost plus 5 per cent basis, and the nitrate products would be sold at prices determined by the Secretary of Agriculture.

What Ford's Representative Said

In the course of his testimony before the House Committee J. W. Worthington, the chairman of the Executive Committee of the Tennessee River Improvement Association, and who has been acting in the interest of Mr. Ford during his negotiations for Muscle Shoals, said:

Nobody who knows Henry Ford will doubt for a minute that he will let the Louisville & Nashville Railroad have the power to electrify the division running through Muscle Shoals.

It has been said that Mr. Ford does not pay enough interest—that he ought to pay more than 4 per cent. It is right there where Mr. Ford is misunderstood. He says that the money changers, some of them, must get out of the water-power temple, and this is what he means: If you take a hydro-electric development with an investment of $200 per horsepower and your money costs 2 per cent, you have an interest charge of $4 per horsepower per year; if it costs 4 per cent, it is $8; if it costs 6 per cent, it is $12; if it costs 8 per cent, it is $16, and if it costs 10 per cent, it is $20. That is the charge the consumer must pay. Mr. Ford's idea is that some way should be devised whereby these water powers can be developed without shocking interest charges.

The Government, while it is lending its credit to Mr. Ford, is financing its own property. You get 4 per cent on your investment and get the return of the principal at the end of the lease period, whereas on the Ohio River, for instance, you never get a single cent interest, and no single penny of the principal is returned. Everybody agrees to the wisdom of the reclamation policy, yet the investment stands today at a net, in your Reclamation Service, of $125,870,830, which you invest to make arid lands productive. You do not get a penny in interest, and the principal is returned very slowly. You can do as much for agriculture with water east of the Mississippi as you do with water in reclamation states, only it is through a different medium. In one case you use the water to get the fertilizer, and out there you put the water on the land.

Dr. Milton Whitney, of the Bureau of Agriculture, testified that the present surplus of nitrogen is temporary, and not permanent, as the National Fertilizer Association maintains. For this reason, he said, the production of nitrates at Muscle Shoals is most desirable from the agricultural viewpoint, and the project should be completed if at all possible.

Col. Hugh Cooper, who has been closely associated with the Muscle Shoals project as a consulting engineer for the Government, told the committee that Mr. Ford should amend his offer so as to pay 4 per cent on the total cost of dams No. 2 and 3 and should bring his proposal within the water power act's limitations.

From the beginning of the hearing it has been evident that the committee attached great importance to lack of definiteness in the Ford offer in the matter of fertilizer manufacture. Even the Secretary of Agriculture qualified his approval of the Ford proposal by specifying that its terms must be found binding so that the plant will be operated continuously for the manufacture of fertilizer. In an effort to meet this objection, Mr. Ford has agreed to alter the contract so as to give a definite guarantee to produce a complete fertilizer at a given minimum annual tonnage.

Alabama Power Co.'s Arguments

The committee concluded the hearings on the Ford offer Feb. 27 and took up discussion of the other proposals. Representatives of the Alabama Power Co. insisted that the Government should uphold the option under which they claimed exclusive right to buy the Warrior steam plant and made it plain that they would actively oppose any effort of the Government to disregard that option and turn over the property to Mr. Ford. It was also stated that the company is willing to buy the plant at a fair price and is even willing to leave the determination of that price to a board of arbitrators. As has been explained previously in *Power*, the difficulty about the Warrior plant is that the Alabama Power Co. owns the property on which it stands, while the Government owns the plant, although during the war it gave the power company an exclusive option to buy it.

A promise to industrialize the territory within a radius of 400 miles of Muscle Shoals was made by Thomas W. Martin, president of the company, in his testimony before the committee. He said that his company had made thorough studies of the power market within this radius, and that these studies had shown that the power should be developed and distributed as a public-utility enterprise.

The Senate has agreed upon a "junket" for its members to Muscle Shoals, and about 45 Senators have indicated their desire to make the trip. Fear has been expressed that, owing to the large number of Senators who would be absent from Washington, it may be necessary to hold up the entire business of the Senate for about five days during the inspection tour.

Correspondence between Director Jones, of the Employment Service of the Department of Labor, and Major-General Beach, Chief of Army Engineers, brought out the fact that employment agencies are "exploiting the people and preying upon the unemployed" by publishing advertisements throughout the country that there is possibility of employment at Muscle Shoals, and soliciting an enrolment fee of one dollar. It was pointed out that Government operations around Muscle Shoals had been shut down for almost a year, and that there was no assurance as to how soon they may be resumed. It was indicated that the Department of Justice might take up the matter with a view to prosecution of the offending "employment" agencies.

The Utah Power and Light Co. has filed an application for a comprehensive development of the power in Green River, between the Flaming Gorge in the northeast corner of the State of Utah and Rattlesnake Creek, a short distance above Greenriver, Utah. It has also filed an application for a preliminary permit to develop all the power in Yampa River, in northwestern Colorado. The proposed developments in Green River consist of six dams, with a power house at each one. These projects, together with the Flaming Gorge and Rattlesnake Creek projects of this company, will have an estimated installed capacity of approximately 1,000,000 horsepower.

An effort is being made by a committee of the American Society of Mechanical Engineers to arouse the industrial leaders of this country to the intensity with which standardization is being carried on in Germany and to the need for such a development here. It is declared that Germany has standardized its products to such an extent that it is likely to capture a leading place in the world's trade and to become a dangerous competitor of American business unless we adopt similar methods. The committee is headed by E. C. Peck, of Cleveland, Ohio.

News in the Field of Power

Power Machinery Makers Report Big Incomes

Companies engaged in the manufacture of electrical machinery, stationary and marine engines and refrigerating machinery paid taxes totaling $19,306,429 in 1919, according to a compilation just completed by the Bureau of Internal Revenue. The number of companies making returns was 343. Of these, 333 companies had net incomes aggregating $66,930,812, and ten companies reported no net incomes, with deficits totaling $316,514.

Of the 1,603 electric light and power companies making income tax returns for 1919, 454 had no net income whatever. Among the 1,046 such companies, however, the net income was 6.53 per cent of the invested capital. The total net income of 1,149 companies was given as having been $49,515,624. On this amount income taxes to the extent of $4,639,440 were paid, in addition to which, war profits and excess profits taxes were paid to the amount of $1,164,563. The deficit reported by the 454 companies reporting no net income was $4,380,909.

How to Get a Bill Paid

Here is a tip for consulting engineers whose bills bring murmurs of protest. The bulletin of the Engineering Society of Buffalo tells of a case in which a bank safe was stuck and no one could open it. Finally, an expert was hired, and in ten minutes the safe was opened.

A bill for $100 soon followed, which moved the bank president to say, "Your bill looks very high. Please itemize it." And itemized it was, thus: "For opening safe, $5; for knowing how, $95."

American River License Granted

A license for a water-power development that is expected ultimately to reach 100,000 hp. was recently authorized for issuance by the Federal Power Commission to the El Dorado Power Co., a subsidiary of the Western States Gas and Electric Co. The project is on the South Fork of the American River, near Placerville, Cal., and involves the use of an existing canal twenty-five miles long, known as the El Dorado Ditch. The head will be 1,900 ft., and there will be six storage reservoirs with an ultimate capacity of 90,000 acre-feet.

Public hearings on the application for this license brought out the interesting fact that the use of as much as possible of the water on the upper American River for power is demanded by the requirements of irrigation. It is shown that by carrying electric power from this project to the highly productive agricultural area near Stockton, about three acres per horsepower could be irrigated by electric pumping, whereas the water of the American River, if used directly for irrigation, would supply only one acre per horsepower.

California Will Be Busy This Year

Twenty-two and a half million dollars will be spent by the Southern California Edison Co., of Los Angeles, during the year 1922, for additional water-power developments and extensions to its transmission and distribution systems, according to a recent announcement of President John B. Miller, who says that this is the largest annual budget appropriation in the history of the company. In addition to this outlay for new work the company expects to spend, for operating and similar expenses, seventeen and a half million dollars more, making a total expenditure for the year of forty million dollars.

About half of the appropriation for new work will be spent on the construction of new water-power plants in the Big Creek and San Joaquin developments, and the other half on transmission and distribution systems covering the greater part of southern and central California. This will mean the employment of 3,500 men on power-plant construction, out of a total of 6,500 employees.

Part of the money required for this work will be secured by the sale of stock to the company's consumers and to the public in central and southern California. As a result of the company's policy of financing itself through individual subscriptions instead of through banking houses, its stockholders now include more than 27,000 individuals.

Yes, We Need Engineering Statesmen

EDWIN T. LUDLOW, in his retiring speech as president of the American Institute of Mining and Metallurgical Engineers at its recent annual meeting in New York, struck the keynote that American engineers should follow if they would realize to the full their opportunities and their responsibilities to the country.

"In the future," he said, "instead of political statesmen taking over more and more of the functions of business and professional leadership, we should see business statesmen, educational statesmen, medical statesmen and engineering statesmen in charge of the Government departments where their professional ability is required."

There is at least one department of the Government where that has been done—the Department of Commerce. Secretary Hoover has shown the public, and even Congress, what the engineer can do—now it is up to the engineer to train himself to grasp the continually widening opportunities that the future will bring him.

Working for Better Eyesight

A campaign of education with the object of showing the danger and inefficiency of defective vision is being carried on by the Eyesight Conservation Council, of which the president is L. W. Wallace, the secretary of the Federated American Engineering Societies.

The Council's objects may be briefly stated as follows: To arouse public interest to the importance of caring for defective eyes and protecting the eyes in hazardous occupations; to disseminate knowledge on the optics of the eye; to circulate information on proper lighting; to bring about universal eye examinations of industrial workers and school children; to develop and improve optical aids for the alleviation of visual troubles; to compile and circulate data on eye care; to co-operate with state and Federal Governments and with all other existing agencies concerned with the movement for better vision.

The Eyesight Conservation Council was formed as the best means of carrying out this work, and is supported entirely by voluntary contributions. It is already distributing literature, including an interesting pamphlet with photographs showing how things look to those with poor eyesight, from its headquarters in the Times Building, New York City.

Japan Developing Power Supply

The activities of Japanese power companies in putting up new plants, adding to existing plants and extending their transmission systems are attracting a good deal of attention. Imports of electrical machinery and supplies to carry on this work have been a feature of international trade in recent months, especially as to hydroelectric equipment, of which Japan ordered machinery totaling 260,000 hp. abroad, and built 150,000 hp. more at home, from January, 1920, to June, 1921.

A study of the situation made by C. A. Powel, an engineer with the Westinghouse Electric and Manufacturing Co., indicates the possibility of a Japanese superpower system that may be the largest in the world. "The topography of the country and the natural resources in this district," he says, speaking of the southern coast of the island, "are conducive to the construction of a superpower system, and the leaders in Japanese industrial life realize this fact."

New Publications

Effect of Heat Treatment on the Mechanical Properties of One Per Cent Carbon Steel. Technologic Paper No. 206, published by the Bureau of Standards. Single copies distributed free by the Bureau at Washington until the free stock is exhausted, additional copies being obtainable from the Superintendent of Documents, Government Printing Office, Washington, at 15 cents apiece.

Results are given of tests that have been made to determine the physical properties produced in one per cent carbon steel by different kinds of heat treatment.

Burning Liquid Fuel. By Dr. William N. Best. Published by the U. P. C. Book Co., Inc., New York City. Cloth, 6 x 9 in., 336 pages; 316 illustrations. Price, $5.

Dr. Best was one of the pioneers in the burning of fuel oil, and he has written this book with the background of 33 years of practical experience in the field. The information is given in simple, non-technical language, so that it can be readily understood by the practical man without technical education. Less than half of the contents deal with the applications of fuel oil to stationary locomotive and marine boilers. The other applications discussed at length are in the gas and sugar industries, steel foundries, heat-treating plants, iron and brass foundries, forge shops, boiler factories, enameling departments, the chemical industry, the copper industry, the ceramic industry, the glass industry, etc.

Investigation of Oxyacetylene and Cutting Blowpipes. Technologic Paper No. 200, published by the Bureau of Standards. Single copies free from the Bureau, additional copies at 35c. from the Superintendent of Documents, Government Printing Office, Washington, D. C.

Standard tests have been applied to the blowpipes of fourteen different manufacturers to determine the efficiency and safety of the apparatus, with especial reference to its design. General results of the tests are given, although, of course, the names of the makers are not mentioned. It is stated by the Bureau that the principles of design of such apparatus are not well understood, and that the conclusions drawn from these tests should be of value to the industry; probably they would prove helpful also to users of this equipment.

Alternating Currents. By Chester L. Dawes. Published by McGraw-Hill Book Co., Inc., New York City, 1922. Cloth, 6 x 8 in.; 526 pages; 406 illustrations. Price, $4.

This book is intended as a companion volume to the authors "Direct Currents" and forms part of the McGraw-Hill Electrical-Engineering Texts. The book in general can be considered as an elementary treatment of alternating currents, and is written for those who have such knowledge of direct current as given in the author's volume on this subject.

The first two chapters are devoted to the fundamental laws of alternating current. In following chapters these laws are applied to alternating-current measurements, machinery and circuits. A brief chapter has also been included on photometry. Mathematics has been used to a considerable extent through the work, and numerous illustrative problems and methods of making laboratory tests are given. Although the primary purpose of the book is for use in classrooms, the home student who has a fairly good grasp of the subject of electricity will find this work of interest.

Personals

Hubert E. Collins, a consulting engineer who is well known in power plant circles, has moved his office to Room 46, Winston Bldg., Utica, N. Y.

E. G. Allen, formerly engineer with the Westinghouse Electric and Manufacturing Co. at So. Philadelphia, has joined the engineering department of the Philadelphia Electric Co.

Henry R. Stevens is to spend some time in Japan as construction engineer with the Daido Electric Power Co. He will act as the representative of Thebo, Starr & Anderton, consulting engineers, of San Francisco.

R. C. Starr has been appointed chief engineer of the Merced Irrigation District Project in California, although he remains chief engineer of the San Joaquin Light and Power Corp. He was chief construction engineer for the company's Kerckhoff plant.

Professor Edward F. Miller, head of the department of mechanical engineering at the Massachusetts Institute of Technology, has been made a colonel in the Ordinance Reserve Corps, U.S.A., in recognition of the work he did for the government during the war. He invented the steam-driven tank.

Edward C. Magdeburger, who was for many years with Busch-Sulzer Bros. Diesel Engine Co., at St. Louis, Mo., as designing engineer, and who more lately was chief engineer of the St. Marys Oil Engine Co., of St. Charles, Mo., builders of Hvid-type oil engines, is now connected with the Navy Department as an aide on Diesel engines in the Bureau of Engineering, at Washington, D. C.

William McClellan and **Peter Junkersfeld** have incorporated as McClellan & Junkersfeld, with temporary offices at 141 Broadway, New York City. They will give their attention to power plants transmission systems, water power development, electrification of railroads, etc. Mr. McClellan is president of the A.I.E.E., and Mr. Junkersfeld was recently engineering manager for Stone and Webster.

Society Affairs

Coming Conventions

American Society of Mechanical Engineers — Spring meeting at Atlanta, Ga., May 8-11. Secy., Calvin W. Rice, 29 West 39th St., New York City.

National Electric Light Association —Annual convention at Atlantic City, N. J., May 15-20. Headquarters, 29 West 39th St., New York City.

Ontario Section, A.S.M.E., will meet March 14 to discuss "Heat Insulation."

New Haven Branch, A.S.M.E., will hold a meeting March 11 at which affiliation of the technical societies of Connecticut will be discussed.

Providence Section, A.S.M.E., will meet March 10 to hear "Heat Balance in Power Plants" discussed by Leo Loeb, of Day & Zimmerman, of Philadelphia.

Detroit Section, A.S.M.E., will meet March 21 to hear about "Recent Developments at Niagara Falls" from John F. Harper, vice president and chief engineer of the Niagara Falls Power Co.

Fort Wayne Section, A.I.E.E., will hear a talk on March 16 on "Automatic Substations," by W. S. Richhart, of the Indiana Service Co. An inspection trip will be included through a local automatic substation.

Hartford Branch, A.S.M.E., is to hold a meeting March 14 at which "Conveyors" and "Furnace Combustion" will be the subjects of motion-picture lectures conducted by representatives of the Lamson Co. and the Sanford Riley Co., respectively.

The National Electric Light Association has announced that an educational electrical exhibition will be one of the features of its Atlantic City convention, which is scheduled for May 15-19. Application blanks have already been sent out, and space will be assigned on March 15.

Virginia Section, A.S.M.E., will hold a meeting March 10 in Murphy's Hotel, Richmond, Va., at which four papers will be given: "History of Steam Power," illustrated, by E. J. Willis, of Richmond; "Gas—Its Manufacture and Distribution," by H. G. Johnson, of Utica, N. Y.; "Pulverized Fuel," by H. D. Savage, of New York; "Coal For Byproducts" and "Lubrication," by W. A. Ludwick, of Norfolk.

Pittsburgh Section, A.I.S.E.E., will hold a meeting March 18 at the Chatham Hotel, at which a paper on "Reducing Power Bills on Mine Fans with Synchronous Motors" will be presented by Frank W. Cramer, engineer of tests for the Cambria Steel Co., and by A. A. McDonald, chief engineer of the Union Coal and Coke Co. Points taken up in the paper will include the use of a synchronous motor with a magnetic clutch and the replacement of steam engines with electric motors.

Business Items

The Wilson Welder and Metals Co., Inc., 132 King St., New York City, has appointed R. L. White as district manager of the Detroit Office, in the Kresge Building.

The General Electric Co. has promoted E. B. Merriam from the position of director of industrial relations to that of executive engineer of the switchboard department. He will coordinate the engineering activities of the switchboard departments at Schenectady, Philadelphia and Baltimore.

The Medart Patent Pulley Co., St. Louis, Mo., has announced the change of its name to the Medart Co. This was made necessary by the increase in scope of the company's products since 1879, when it was organized to manufacture the Medart patented steel-rim pulley. Its products now include a complete line of lineshaft and similar equipment.

The Pelton Water Wheel Co., of San Francisco, Cal., has been taken over, according to unofficial but reliable information, by the William Cramp and I. P. Morris interests. It is understood that the company's New York office will be permanently closed, and that L. F. Moody, who went to San Francisco several weeks ago, will remain in that city to direct the activities of the Pelton company under its new ownership.

The Permutit Co., 440 Fourth Ave., New York City, has announced that its patent covering its Zeolite water softeners has been sustained by the United States Circuit Court of Appeals, Second Circuit, N. Y., which affirmed a previous decision of the Federal Court at Buffalo, N. Y. The decision praises the invention in question, and declares that all Zeolite water softeners on the market not made by the Permutit Co. are an infringement of its patent.

Trade Catalogs

Pyrometers—Thwing Instrument Co., 3339 Lancaster Ave., Philadelphia, Pa. Bulletin 10, describing the construction and application of Thwing thermo-electric pyrometers.

Recording Thermometers—American Steam Guage and Valve Co., Boston, Mass. Short folder on an improved type of recording thermometer that embodies several new features.

Feed Water Regulation—The "S-C" Regulator Manufacturing Co., Fostoria, Ohio. Catalog No. 30, 64 pages, devoted chiefly to explanations and descriptions of various apparatus for regulating feed-water supply, this part being especially valuable to practical men. Other products also, such as pump governors, relief valves, check valves, etc., are described.

Carbon Brushes, Their Selection and Application—Corliss Carbon Co., Bradford, Penn. A new catalog containing descriptions, illustrations and prices, but, of greater importance, a large amount of practical information that the operating man should find extremely useful in choosing the right kind of brush and using it successfully.

Coal Crushers—The Jeffrey Manufacturing Co., Columbus, Ohio. Catalog No. 359, on the Jeffrey single-roll coal crushers, which are built in sizes from 18 x 18 in. to 36 x 54 in. and are designed especially to make possible a constant supply of stoker or small coal in cases were stoker sizes cannot always be secured direct from mines and only run-of-mine or lump coal is available.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run bases, f.o.b. mines):

Coal	Market Quoting	Feb. 20, 1922	Feb. 27, 1922
Pool 1,	New York	$3.00	$2.75@3.25
Pocahontas,	Columbus	2.10	2.00@2.25
Clearfield,	Boston	1.95	1.65@2.25
Somerset,	Boston	1.90	1.75@2.00
Pittsburgh,	Pittsburgh	2.15	2.10@2.20
Kanawha,	Columbus	1.65	1.50@1.75
Hocking,	Columbus	1.90	1.75@2.00
Pittsburgh No. 8	Cleveland	1.95	1.95@2.00
Franklin, Ill.,	Chicago	2.50	2.25@2.75
Central, Ill.,	Chicago	2.35	2.25@2.50
Ind. 4th Vein,	Chicago	2.50	2.35@2.65
Standard,	St. Louis	1.95	1.85@2.00
West Ky.,	Louisville	1.85	1.70@2.00
Big Seam,	Birmingham	1.85	1.70@2.00
S. E. Ky.,	Louisville	2.60	2.50@2.65

New York—On Mar. 1, Port Arthur light oil 22@25 deg. Baumé 4c. per gal. 30@35 deg., 5c. per gal., f.o.b. Bayonne, N. J.

Chicago—Feb. 21, for 24@28 deg. Baumé, 85@90c. per bbl.; 32@36 deg., 2⅜@2½c. per gal. in tank cars f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—On Feb. 21, f.o.b. refinery, Pennsylvania, 38@40 deg. 4c@4¼c. Kentucky fuel oil, 26@30 deg., 3c. per gal.

St. Louis—Feb. 25, prices f.o.b. cars, tank lots; 24@26 deg. Baumé, 85c. per bbl.; 26@28 deg., 90c.; 28@30 deg., $1.00; 32@34 deg., 2⅜c. per gal.

Philadelphia—On Feb. 27, 26@28 deg. Baumé, Oklahoma, 80@90c. per bbl.; 30@34 deg., Oklahoma (group 3) 2¼@2⅜c. per gal.; 16@20 deg., Seaboard, $1.00@$1.10 per bbl.

Cincinnati—Feb. 27, for 26@30 deg. Baumé, 5c.; Diesel 32@34 deg., 5¼c. per gal.; distillate 38@46 deg., 6c. per gal.

Cleveland — Feb. 27, 26@30 deg. Baumé, 4c. per gal.

New Plant Construction

PROPOSED WORK

Cal., Berkeley—The University of California received bids for furnishing and installing power plant equipment for dairy and power plant from C. T. Doell, 467 21st St., Oakland, $16,468; Hately & Hately, Mitau Bldg., Sacramento, $18,238; Scott Co., 243 Minna St., San Francisco, $19.695.

Cal., Burlington—Trustees of San Mateo Union High School District, will receive bids until March 16 for a 2 story high school including a heating and ventilating system. About $360,000. Noted Jan. 17.

Cal., Chico—J. B. Thompson, Engr. 3rd and Bway., is preparing plans for an irrigation project in Butte County to include the construction of a dam 250 ft. high and 2,200 ft. long also 54 miles of lined canals.

Cal., Los Angeles—Price & Paden, 605 Story Bldg., had plans prepared for a 12 story, 50 x 155 ft. office bldg. including a steam heating system on 8th and Spring Sts. About $400,000. L. A. Smith, 804 Higgins Bldg. Archt.

Cal., Oakland—The Oakland Laundry Co., 730 29th St., is having plans prepared for a 1 story boiler room on 29th St. About $4,000. S. B. and N. Newson, Nevada Bank Bldg., San Francisco, Archts.

D. C., Washington—H. Wardman, 1430 K St., plans to build an apartment hotel. About $1,000,000. Private plans.

Fla., Orlando—The city voted $607,000 bonds to purchase the water works and electric power plant of the Orlando Light & Water Co., also $360,000 to be used in rehabilitating both plants and to extend lighting and water systems. Noted Jan. 31.

Ill., Breese—The city, c/o City Clk. plans to build an addition to power plant including the installation of new boiler. About $34,000. Fuller & Beard, Railway Exchange Bldg., St. Louis, Mo., Engr.

Ill., Chicago—The Southern Coal Coke & Mining Co., 28 East Jackson Blvd., is in the market for two 150 or 200 hp. fire tube or water tube boilers, 150 lbs. pressure.

Ill., Danville—Aschauer & Waggoner, Citizens Bank Bldg., Decatur, are preparing plans for a 1 story garage and heating plant. About $50,000. Owner's name withheld.

Ill., Decatur—The Illinois Traction System, Mayer Bldg., Peoria, is having plans prepared for an electric generating plant. About $600,000. H. E. Chubbuck, Peoria, Mgr. Private plans.

Ill., Joliet—The Union Coal Transfer & Warehouse Co., A. Lindberg, Genl. Mgr., is having plans prepared for a 1 story, 50 x 160 ft. ice plant and warehouse on Henderson St. About $40,000. Private plans. Ice machinery will be installed sufficient to manufacture 40 tons per day.

Ill., Peoria—Clark & Co., c/o Hewitt & Emerson, Archts., 1600 Peoria Life Bldg., is having plans prepared for an 8 story, 72 x 85 ft. department store including a steam heating system. About $250,000.

Ill., Rockford—Peterson & Johnson, Archts., 406 Swedish American Bank Bldg., is preparing plans for a 5 story, 100 x 300 ft. factory and a 1 story power plant and dry kiln. About $500,000. Owner's name withheld.

Ill., Rock Island—The Augustana College, Bd. of Supervisors, G. A. Andreen, Pres., will receive bids until March 18 for a 2 story seminary and dormitory building, including a steam heating system. About $400,000. Cervin & Horn, 310 Safety Bldg., Archts. Noted Sept. 20.

Ind., Ft. Wayne—The Fairfield Manor Apt. Corp., O. N. Guldin, Pres., 2306 Fairfield Ave., is receiving bids for a 6 story, 60 x 182 ft. apartment on Washington St. About $750,000. C. R. Weatherhogg, Citizens Trust Bldg., Archt.

Ind., Huntington—The Huntington Ice Co., Inc., plans to build a 2 story ice plant. About $40,000. Architect not selected.

La., Amite—The Central Light & Power Co., Ltd., E. H. Burnham, Mgr., is in the market for one 500 KW. 3 phase, 60 cycle, 3,600 R.P.M. high pressure turbo generator complete with barometric condensing

equipment; three 330 KW. 600 volt to 33,000 volt. transformers; six 100 KW. 33,000 to 2,200 volt transformers; 100 miles No. 6 and No. 8 bare copper; 6,000-33,000 volt insulators; lightening arrestors and equipment for 33,000 volts and various pole line equipment.

Mich., Bay City—W. H. Reid, City Mgr., City Hall will receive bids until March 16 for a steam driven high service pumping unit complete with condenser and auxiliaries; three 275 hp. water tube boilers; coal and ash handling system; and brick chimney.

Mich., Detroit—The Thompson Realty Co., c/o Esselstyn & Murphy, Archts., Marquette Bldg., is having plans prepared for a 2 story, 427 x 700 ft. mercantile building, including a steam heating system on Woodward Ave. About $400,000.

Mo., St. Charles—The city plans improvements to waterworks and electric plant. About $250,000. Benham & Mullergreen, Firestone Bldg., Kansas City, Engrs.

Neb., Culbertson—W. J. Mohr, City Clk., plans additional motor and pump also about 4,000 ft. of 4 in. and 6 in. mains. About $15,000. Hershey & Merick, Brownell Bldg., Lincoln, Engrs.

Neb., Imperial — The Bd. Directors Frenchman Valley Irrigation Dist., J. L. Kilburn, Secy., will receive bids until March 21 for a dam, pipe lines, etc. About $125,000. Hershey & Merick, Brownell Bldg., Lincoln, Engrs.

Nev., Reno—E. H. Beemer, County Clk., will receive bids until March 22 for furnishing one 6 hp. high pressure vertical steel boiler and one 30 in. by 86 in. steam disinfector with formaldehyde attachment.

N. Y., Brooklyn—The New York Telephone Co., 15 Dey St., is having plans prepared for an 8 story addition to telephone exchange on Willoughby Ave. About $1,000,000. McKenzie, Voorhies & Gruelin, 1123 Bway., New York City, Archts.

N. Y., New Brighton (Staten Island)—The Bd. Educ., C. B. J. Snyder, Supt., Municipal Bldg., New York City, received bids for installing heating and ventilating system in Curtis High School on Hamilton Ave. and St. Marks Pl., from D. J. Rice, 405 Lexington Ave., New York City, $58,-[illegible]; J. E. Kahn, 224 West 20th St., New York City, $61,419; and the Federal Htg. Co., 300 2nd Ave., $61,491. Noted Feb. 21.

N. Y., Newburgh—The city, W. J. McKay, Mgr., will receive bids until March 20 for the construction of a mechanical filter plant. Seven electrically operated centrifugal pumps to be installed in the headhouse. G. W. Fuller, and J. C. Harding, 170 Bway., New York, Engrs.

N. Y., New York—The Comr. Water Supply, Municipal Bldg., will receive bids until March 10 for furnishing and installing and connecting a boiler at the 98th St. pumping station.

N. Y., Mechanicville—T. C. Luther is in the market for equipment for lumber and planing mill also boiler and engine.

N. Y., New York—The Estate of A. S. Rosenbaum, c/o Bottomley, Sugarmant & Hess, Archts., 112 East 55th St. is having plans prepared for a 12 story, hotel on University Place and 10th St. About $750,000.

N. Y., New York—H. H. Uris, c/o A. C. Bossom, Archt., 680 5th Ave., will soon receive bids for an apartment on 108th St. and Riverside Dr. About $550,000.

N. Y., New York—The 588 West End Ave., Corp., c/o Schwartz & Gross, Archts., 347 5th Ave., is having plans prepared for an apartment including a steam heating system on West End Ave. About $500,000.

N. C., Barber—D. R. Murphy is in the market for a 15 hp. Cornish boiler.

N. C., Enfield—The city, A. W. Andleton, Mayor, will receive bids until March 15 for an electric light plant and pumping equipment. About $50,000. W. C. Olsen, Kinston, Engr. Noted Jan. 31.

N. C., Hickory—G. W. Hall plans to build a hotel. About $250,000. F. B. Simpson, 110 East Lane St., Archt.

N. C., Lexington—G. W. Smith, 310 East Center St. is in the market for a steam boiler and engine, 40 to 50 hp.

N. Dak., Fargo—The Union Light, Heat & Power Co., plans a substation on Bway. and Roberts St. About $30,000. Engineer not selected.

O., Cincinnati—The Norton-Broadway Mchy. Co., 238 Bway., W. G. Norton, Purch. Agt., in the market for two 72 in. x 18 ft. boilers, 125 lbs. pressure, Indiana test and one 200 or 250 hp. Corless engine to be shipped to Wisconsin (used).

O., Cincinnati—The Randle Mchy. Co., Cincinnati, Hamilton & Dayton R. R. and Powers St., W. E. Randle, Jr., Purch. Agt. is in the market for two 66 x 16 full front boilers for 125 to 150 lbs. pressure and one 100 to 200 K.W. A.C. generator set.

O., Toledo—The Bd. Educ. will receive bids until March 13 for a 3 story, 160 x 200 ft. school. About $275,000. Private plans.

O., Wellsville—The city is having preliminary plans prepared for the construction of a dam, 3½ miles pipe line and a filteration plant of 2,500,000 gal. capacity. About $300,000. Morris-Knowles, Inc., 1003 Hanna Bldg., Cleveland, Engrs.

O., Zanesville—The Pure Ice Co., Underwood St., is having plans prepared for a 1 story, 50 x 50 ft. ice plant. About $50,000. A. C. Bishop & Co., 427 Guardian Bldg., Cleveland, Archts. and Engrs.

Ore., Portland—The Emanuel Hospital, 212 Stanton St., is having plans prepared for a 6 story hospital, on Graham and Commercial Sts. About $250,000. E. Kroner, Worcester Bldg., Archt.

Pa., Cranesville—H. P. Bateman Bros. are in the market for a portable boiler and engine capacity 16 to 25 hp.

Pa., Oil City—S. Messner, 433 Chambers Bldg., is in the market for an oil burning boiler.

Pa., Phila.—S. R. Bleckson, 667 North Broad St., is having plans prepared for a 14 story, 100 x 156 ft. hotel and stores building on Juniper and Locust Sts. About $1,500,000. L. B. Rothchild, 1211 Sansom St., Archt.

Pa., Phila.—The Bd. Educ. will receive bids until March 10 for a 3 story, 198 x 210 ft. high school including an indirect heating system on 24th St. and Snyder Ave. About $800,000. Private plans.

Pa., Phila.—The city received bids for a pumping station, Contract No. 567 from Kober Constr. Co., 34 South 17th St., $15,-109; G. H. Evans Inc., 109 North 13th St., $15,440; and H. E. Baton, 1713 Sansom St., $16,784.

Tenn., Nashville—The city, F. Wilson, City Hall, plans to rebuild the municipal light plant on 1st St. N., recently destroyed by fire. About $100,000. Architect not selected. Machinery and equipment will be installed.

Tex., El Paso—The city will soon receive bids for two 24 in. centrifugal pumps with a capacity of 1,040 gal. per min., a 75 hp. motor needed with each, also two booster pumps with capacity of 1,040 gal. per min. against a 205 ft. head, a 125 hp. motor needed for each. Pumps to be centrifugal 24 in.

Va., Norfolk — Peebles & Ferguson, Archts., Law Bldg., will receive bids until March 9 for a 12 story, 25 x 120 ft. bank and office bldg. on Main St. for the Natl. Bank of Commerce. About $500,000.

Va., Winchester—The Winchester Lumber Corp. is in the market for 100 or 125 hp. engine.

Wash., Olympia—W. P. Wilder, Archt., will receive bids until March 13 for a 2 story, 176 x 334 ft. administrative bldg. on the Capitol grounds for the State Capitol. About $400,000.

Wis., Madison—The city, H. C. Buser, Clk., is having sketches made for portable pumping outfits with capacity of at least 1,000 gal. per minute. E. E. Parks, City Hall, Engr. Noted Jan. 24.

Wis., Milwaukee—The Sewerage Comn., J. H. Fowler, Secy., City Hall, will receive bids until March 10 for the structural steel for a 90 x 225 ft. main power house and a 68 x 166 ft. boiler plant on Jones Island.

Wis., Richland Center—The city c/o Clerk, City Hall, plans installation of a 400 hp. unit in electric power plant. Engineer not selected.

Wis., Sheboygan—H. C. Prange Co., 8th and Wisconsin Ave., will receive bids about March 15 for a 3 or 4 story, 65 v 90 ft. power and heating plant. About $60,000. W. C. Weeks, 720 Ontario Ave., Archt. Noted Jan. 24.

Ont., London—The Western University, Col. W. J. Brown, is having plans prepared for a 2 story, 90 x 90 x 200 x 300 ft. university buildings including a steam heating system on North London St. About $1,000,-000. Prices wanted on all materials. J. M. Moore, 489 Richmond St., London, Archt.

Ont., Ridgetown—The Township Council, G. McDonald, is having plans prepared for hydro line for power and lighting. About $35,000. E. R. Lawlor, 190 University Ave., Toronto, Engr.

Ont., Sturgeon Falls—The Northern Ontario Light & Power Co., Ltd., Cobalt, is considering the development of the Sturgeon Falls, on the Mattagami River, project, here. About 7,000 hp. Cost between $350,000 and $600,000.

Ont., Thedford—The Township Council, G. Sutherland, plans electric lighting and power distribution system. About $30,000. A. Wilson, 190 University Ave., Toronto, Engr. Work will be done under direction of Hydro Comn.

Que., Montreal—Corporation of Montreal, Chn. Executive Committee, City Hall, will receive bids until March 15 for furnishing, installing complete switching equipment for the control of the operation of electrical pumping units in new pumping station.

Que., Montreal—E. Lopage, 990 Parthanais St., is in the market for one 25 hp. electric motor.

Que., Montreal—The Maple Dairy, Ltd., 2828 St. Hubert St., J. Carr, Purch. Agt., in the market for one 20 hp. electric motor and one 10 hp. steam boiler.

CONTRACTS AWARDED

Cal., San Diego—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., has awarded the contract for a refrigerating and cold storage plant at the Naval Base Hospital to Wittenmeier, Mchy. Co., 650 North Spaulding Ave., Chicago, Ill., $29,970. Noted Feb. 16.

Cal., San Francisco—The Great Western Power Co., 14 Sansome St., has awarded the contract for a 1-story addition to power plant on Rush and Grant Aves. to Barrett & Hilp, 918 Harrison St. About $18,000.

Ill., Chicago—C. R. Gleason, 111 Washington St., has awarded the contract for a 3 story, 128 x 211 ft. apartment on Brompton and Pine Grove Sts. to Nelson & Berg, 7648 East Lake St. About $450,000. A steam heating system will be installed.

Ill., Rockford—The Chicago Grain Products Co., 1602 South Main St. has awarded the contract for a 50 x 56 ft. power plant, to Swords Bros. About $30,000. Noted Feb. 14.

Kan., Downs—The United Light & Power Co. has awarded the contract for a 1 story, 50 x 76 ft. power plant, to M. J. Green, Manhattan, Kansas. About $30,000.

Md., Crisfield—The McCready Memorial Hospital has awarded the contract for a 3 story hospital to include a 40 x 40 ft. power plant, to the North Eastern Construction Co., Lexington Bldg., Baltimore, $250,000.

N. Y., New York—H. Claman, 24 West 43rd St., will build a 15 story hotel on 8th Ave., between 43rd and 44th Sts. Owner will ouild by day labor. Noted Jan. 31.

N. Y., New York—A. J. Schwarzler, 1340 Brook Ave., will build a 12 story apartment on Clifford Pl. About $1,000,000. A steam heating system will be installed. Owner will build by day labor.

O., Cleveland—The Brooklyn Ice Co., H. E. Miller, Treas., 3323 Henniger Rd., has awarded the contract for a 1 story, 35 x 100 ft. ice plant to F. A. Skeel Constr. Co., 3719 Cyprus Ave. About $40,000.

Pa., Phila.—The Gotham Silk Hosiery Co., 2nd and Norris Sts., has awarded the contract for a 10 story, 56 x 122 ft. and 20 x 20 ft. hosiery factory to W. Steele & Sons, 16th and Arch Sts. About $500,-000. Power plant is under consideration.

R. I., Providence—The Brown University has awarded the contract for a 3 story, 50 x 224 ft. chemical laboratory on Waterman St., to E. Corning Co., 145 East 45th St., New York City. About $500,000.

S. D., Brookings—The State College of Agriculture & Mechanical Arts, T. W. Dwight, Pres., has awarded the contract for a 41 x 41 ft. power plant to Woldmork Constr. Co., Pierre. About $30,000. Noted Feb. 13.

Tenn., Nashville—The State Bd. of Administration has awarded the contract for the construction of a home for Feeble Minded on Stewarts Ferry Pike to include two dormitories, and administration bldg., power house, etc. to G. B. Howard & Co., 148-B 4th Ave., N. About $219,000. Noted Aug. 30.

Va., Hampton Roads—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., has awarded the contract for motor generator sets and switchboard at the Naval Base Hospital to the General Electric Co., River Rd., Schenectady, N. Y., $16,860. Noted Feb. 28.

W. Va., Wheeling—McLure Bros., Steel Corp. Bldg., has awarded the contract for an 8 story, 90 x 100 ft. hotel on Market St. to R. R. Kitchin Co., Natl. Bank Bldg., $250,000.

Wis., Brillion—The village, E. Gruett, Clk., has awarded the contract for furnishing and laying sanitary and storm sewers to M. F. Rebbens, Mayville, $21,645. Bids will be received later for pumping station. Noted Jan. 24.